Being Locked Up Hurts

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This version: January 12, 2009

ABSTRACT

This paper examines multi-period asset allocation when portfolio adjustment is difficult or impossible for some assets due to the existence of lockup periods. Our empirical analysis shows that both unconditional and conditional portfolios benefit from adding hedge funds. More importantly, both unconditional and conditional portfolios overestimate their performance with stocks, bonds and hedge funds when we overlook the effect of a lockup period on performance. The annualized Sharpe ratio of an unconditional portfolio with a three-month hedge fund lockup period and monthly rebalancing of stocks and bonds is 1.225, which is significantly lower than the annualized Sharpe ratio of the same portfolio assuming no lockup period, 1.533. Investors compensate for the lockup period of hedge funds by making adjustments to their equity holdings. For conditional portfolios, the difference in Sharpe ratios and equity holdings due to a lockup period for hedge funds is also significant. Finally, the effect of a lockup period on portfolio performance is less pronounced when investing in funds of funds relative to investing in individual hedge funds, suggesting that funds of funds may help suppress the effect of a lockup period.

JEL classification: G11; G12

Keywords: Multi-period asset allocation; return predictability; hedge funds; lockup period.

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I. Introduction

An important question for both practitioners and academics in portfolio analysis is the multiperiod investment problem. The question is how to rebalance the portfolio before the investment horizon, which is often complicated by restrictions such as the inability to go short and the fact that some positions in illiquid assets cannot be rebalanced easily. In addition, predictability in asset returns has non-trivial rebalancing effects in multiperiod investment problems.

There is increasing empirical evidence for predictability in asset returns[1] and for the fact that many institutional investors show an increasing allocation to hedge funds, private equity and venture capital (Source: The 2007-2008 Russell Investments Survey on Alternative Investing). In this paper, we study the asset allocation problem for an investor when some of the assets such as hedge funds have lockup periods. The analysis extends Brandt and Santa-Clara (2006) where the multi-period investment portfolio is solved in a static Markowitz-framework. We take the perspective of a mean-variance investor who periodically adjusts a portfolio that consists of liquid assets and illiquid assets during the investment period. We show that hedge fund lockup can be incorporated into the multi-period asset allocation decision by an investor who periodically re-adjusts his portfolio. In addition, we find that lockup periods considered in this paper are empirically highly relevant. Our empirical analysis shows that even with a hedge fund lockup, investing in hedge funds can improve portfolio outcomes in both the unconditional and conditional context.

Moreover, we contribute to the hedge fund literature by evaluating investments in hedge funds from a portfolio perspective. The evaluation of hedge fund performance has been studied in several papers, including Agarwal and Naik (2004), Fung, Hsieh, Naik and Ramadorai (2008), Kosowski, Naik, and Teo (2005), Malkiel and Saha (2005). In these studies, the performance of individual hedge funds or groups of hedge funds is evaluated on the basis of an asset-pricing model. We take the portfolio perspective and compute the optimal allocation to different asset classes in a portfolio. Asset classes such as hedge funds are often considered attractive investments because of their superior risk-return profile and low correlation with

[1] See Campbell (1987), Campbell and Shiller (1988a), (1988b), Cochrane (2007), Fama and French (1988), (1989), Keim and Stambaugh (1986), Hodrick (1992), and Lettau and Ludvigson (2005).

stocks and bonds. However, investments in hedge funds often face more restrictions than investments in stocks and bonds. Most hedge funds impose a lockup period, ranging from a few months up to several years, during which investors cannot withdraw their capital. As the lockup periods lengthen, the negative effect of having such illiquid assets grows and may lead to the situation that a portfolio of liquid assets and illiquid assets is dominated by a portfolio of only liquid assets.

As in Brandt and Santa-Clara (2006), we solve a multi-period portfolio problem that consists of a set of timing portfolios. In a multi-period setting, a timing portfolio for a risky asset is a strategy that invests in the risky asset in one period only and in a risk-free asset in all remaining periods. Therefore, the multi-period asset allocation can be derived by solving the static Markowitz problem on the basis of timing portfolios and scaled returns or conditional portfolios. We incorporate the constraint of a lockup period for hedge funds to the asset allocation problem. If we assume that the investment horizon is equal to the length of the lockup period, there is no timing portfolio for hedge funds, because once an investment in hedge funds is made, the investor has to hold it until the lockup restriction expires. A portfolio of stocks, bonds and hedge funds with a lockup will certainly behave differently than a portfolio of the same assets without a lockup, in terms of allocation to different assets over time, as well as portfolio performance. Indeed, we find that the lockup period induces hedge demand for stocks in order to obtain the desired intertemporal equity exposure that cannot be obtained by hedge funds due to the lockup.

The paper uses broad market indexes as the proxy for stocks, bonds and hedge funds in the empirical analysis. Our empirical analysis in this paper shows that both unconditional and conditional portfolios can be improved upon when adding hedge funds to the stock/bond portfolio, but we may overestimate the portfolio performance when we overlook the effect of a lockup on performance. For instance, the annualized Sharpe ratio for an unconditional portfolio with stocks, bonds and hedge funds with a three-month lockup period is 1.225, which is significantly higher, both economically and statistically, than the Sharpe ratio of 0.907 for an unconditional portfolio of stocks and bonds only. But when the lockup period is ignored, the investor may believe that the portfolio Sharpe ratio with three asset classes is 1.533, which is significantly different from the reported 1.225 at the 1% level. The effect of a lockup period is stronger when the HFRI composite index and the HFRI strategy indexes are considered than for the fund of funds indices. This suggests that fund of fund managers may be able to structure their fund in such a way that their clients are hurt less by lockup periods.

The rest of the paper is organized as follows. Section II explains the methodology to derive the optimal asset allocation for a mean-variance investor facing lockup periods for some assets. Section III presents the empirical results. Finally, Section IV concludes.

II. Asset Allocation with Lockup Periods

We consider a conditional asset allocation problem for a risk-averse investor. The portfolio consists of liquid assets and illiquid assets. Liquid assets include stocks, bonds, money market instruments, etc., while illiquid assets can be hedge funds, private equity and venture capital investment. The investor can change the allocation to liquid assets every period, but adjusting allocations to illiquid assets is difficult if not impossible. The form of illiquidity in this paper is restricted to the situation in which a lockup period is imposed for investments in hedge funds.

A. Multi-period Asset Allocation with Lockup Constraints

We first illustrate the two-period asset allocation problem with lockup constraints, and generalize the method for longer period setting. There are K_1 liquid risky assets and K_2 illiquid risky assets with a lockup period equal to L. For simplicity, the investment horizon has the same length as the lockup period. Consider the two-period quadratic utility optimization problem for an investor:

$$\max \; E_t\left[r^p_{t\to t+2} - \frac{\gamma}{2}\left(r^p_{t\to t+2}\right)^2 \right], \tag{1}$$

where $r^p_{t\to t+2}$ is the excess portfolio return over two periods and γ is the coefficient of risk aversion. Denote portfolio weights on liquid assets and illiquid assets at time t by $w_{z,t}$ and $w_{x,t}$, respectively. In addition, denote the one-period gross return at time t on the risk-free asset by R^f_t, and gross returns of illiquid assets by R^x_{t+1}. The vector r_{t+1} contains one-period excess returns of liquid risky assets. The two-period excess return of the portfolio with only liquid assets in Brandt and Santa-Clara (2006) is:

$$r^p_{t\to t+2} = \left(R^f_t + w'_t r_{t+1}\right)\left(R^f_{t+1} + w'_{t+1} r_{t+2}\right) - R^f_t R^f_{t+1}$$

$$= w_t'\left(R_{t+1}^f r_{t+1}\right) + w_{t+1}'\left(R_t^f r_{t+2}\right) + \left(w_t' r_{t+1}\right)\left(w_{t+1}' r_{t+2}\right)$$
$$\approx w_t'\left(R_{t+1}^f r_{t+1}\right) + w_{t+1}'\left(R_t^f r_{t+2}\right). \quad (2)$$

Because r_{t+1} and r_{t+2} are excess returns, the product $\left(w_t' r_{t+1}\right)\left(w_{t+1}' r_{t+2}\right)$ is very small at short horizons, so the excess portfolio return over the two period is approximately the sum of $w_t'\left(R_{t+1}^f r_{t+1}\right)$ and $w_{t+1}'\left(R_t^f r_{t+2}\right)$.

Brandt and Santa-Clara (2006) interpret $w_{z,t}'\left(R_{t+1}^f r_{t+1}\right)$ and $w_{z,t+1}'\left(R_t^f r_{t+2}\right)$ as "timing portfolios". First, $w_{z,t}'\left(R_{t+1}^f r_{t+1}\right)$ is the two-period excess return from investing in risky assets at time t and then investing in the risk-free asset. Second, $w_{z,t+1}'\left(R_t^f r_{t+2}\right)$ is the two-period excess return from investing in the risk-free asset at time t and then investing in risky assets.

When a portfolio includes assets with a two-period lockup, the two-period portfolio excess return takes the form of the following:

$$r_{t\to t+2}^p = \left(R_t^f + w_{z,t}' r_{t+1}\right)\left(R_{t+1}^f + w_{z,t+1}' r_{t+2}\right) - R_t^f R_{t+1}^f + w_{x,t}' r_{t\to t+2}^x$$
$$\approx w_{z,t}'\left(R_{t+1}^f r_{t+1}\right) + w_{z,t+1}'\left(R_t^f r_{t+2}\right) + w_{x,t}' r_{t\to t+2}^x . \quad (3)$$

where $r_{t\to t+2}^x$ is the K_2 dimensional vector of excess returns of illiquid assets, and for each illiquid asset, $r_{i,t\to t+2}^x = R_{i,t+1}^x R_{i,t+2}^x - R_t^f R_{t+1}^f$ for $i = 1,2,...,K_2$. For investment in illiquid assets, one dollar will grow by $R_{i,t+1}^x R_{i,t+2}^x$ and after paying back the risk-free loan, the two-period excess return on illiquid assets is $R_{i,t+1}^x R_{i,t+2}^x - R_t^f R_{t+1}^f$. There is no "timing" portfolio for illiquid assets since they are locked up over the two periods.

The S dimensional vector of z_t is a set of state variables available to investors at time t. The portfolio weights are assumed to be linear in state variables. For liquid risky assets,

$$w_{z,t} = \beta_1 z_t \text{ and } w_{z,t+1} = \beta_2 z_{t+1}, \quad (4)$$

where the matrix β_1 and β_2 both have a dimension of $K_1 \times S$. For illiquid assets, we have

$$w_{x,t} = \beta_x z_t , \quad (5)$$

where β_x is a $K_2 \times S$ matrix.

The two-period portfolio excess return in (3) then becomes

$$r_{t\to t+2}^p = \left(\beta_1 z_t\right)'\left(R_{t+1}^f r_{t+1}\right) + \left(\beta_2 z_{t+1}\right)'\left(R_t^f r_{t+2}\right) + \left(\beta_x z_t\right)' r_{t\to t+2}^x . \quad (6)$$

Using some linear algebra, we find

$$(\beta_1 z_t)'(R_{t+1}^f r_{t+1}) = vec(\beta_1)' R_{t+1}^f (z_t \otimes r_{t+1}) \ , \tag{7}$$

$$(\beta_2 z_{t+1})'(R_t^f r_{t+2}) = vec(\beta_2)' R_t^f (z_{t+1} \otimes r_{t+2}) \ , \tag{8}$$

$$(\beta_x z_t)' r_{t\to t+2}^x = vec(\beta_x)'(z_t \otimes r_{t\to t+2}^x). \tag{9}$$

where $vec(\beta_j)$ is a vector that stacks the columns of the matrix β_j, $j = 1,2,x$, and $\otimes$ is the Kronecker product. The investment menu becomes a set of scaled returns or expanded asset return space, $\tilde{r}_{t+1} = z_t \otimes r_{t+1}$, $\tilde{r}_{t+2} = z_{t+1} \otimes r_{t+2}$ and $\tilde{r}_{t\to t+2}^x = z_t \otimes r_{t\to t+2}^x$. The investor's problem is to choose a set of unconditional weights to maximize the multi-period mean-variance utility:

$$\max_{\tilde{w}} \ E_t\left[\tilde{w}'\tilde{r}_{t\to t+2} - \frac{\gamma}{2}\tilde{w}'\tilde{r}_{t\to t+2}\tilde{r}_{t\to t+2}'\tilde{w}\right], \tag{10}$$

where the unconditional portfolio weights is $\tilde{w}' = \left(vec(\beta_1)' \quad vec(\beta_2)' \quad vec(\beta_x)'\right)$, and $\tilde{r}_{t\to t+2}' = \left(\left(R_{t+1}^f \tilde{r}_{t+1}\right)' \quad \left(R_t^f \tilde{r}_{t+2}\right)' \quad \left(\tilde{r}_{t\to t+2}^x\right)'\right)$. The portfolio weights $\tilde{w}$ that maximize the conditional expected utility at all dates t should also maximize the unconditional expected utility. The optimization still makes use of the static Markowitz approach on the basis of the unconditional moments of scaled returns. The optimal unconditional portfolio weights are:

$$\tilde{w} = \frac{1}{\gamma} Var[\tilde{r}_{t\to t+2}]^{-1} E[\tilde{r}_{t\to t+2}]. \tag{11}$$

The sample analogue of the population moments in the equation (11) leads to a consistent estimate of the unconditional portfolio weights $\tilde{w}$. It is a vector of the length $(2K_1S + K_2S)$, and we can recover the optimal portfolio weights on K_1 risky assets at time t and $t+1$, $w_{z,t}$ and $w_{z,t+1}$ as

$$w_{z,t}^i = \left(\tilde{w}_{(i)} \quad \tilde{w}_{(i+K_1)} \quad \cdots \quad \tilde{w}_{(i+(S-1)K_1)}\right) z_t \ , \ i = 1,2,\cdots,K_1 . \tag{12}$$

$$w_{z,t+1}^i = \left(\tilde{w}_{(i+K_1S)} \quad \tilde{w}_{(i+K_1+K_1S)} \quad \cdots \quad \tilde{w}_{(i+(S-1)K_1+K_1S)}\right) z_{t+1} \ , \ i = 1,2,\cdots,K_1 . \tag{13}$$

For illiquid assets, the portfolio weights at time t can be derived in the same way as those of liquid risky assets.

$$w_{x,t}^i = \left(\tilde{w}_{(i+2K_1S)} \quad \tilde{w}_{(i+K_2+2K_1S)} \quad \cdots \quad \tilde{w}_{(i+(S-1)K_2+2K_1S)}\right) z_t \ , \ i = 1,2,\cdots,K_2 . \tag{14}$$

However, the static optimal portfolio weights in (11) do not give direct solutions to the portfolio weights of illiquid assets at time $t+1$. We can normalize the initial portfolio value to one and the portfolio weight of illiquid assets i is the ratio of its value to the portfolio value at time $t+1$.

We can generalize the method above to the L-period asset allocation problem with lockup constraints on certain risky assets. The optimal unconditional portfolio weights are

$$\tilde{w} = \frac{1}{\gamma} Var[\tilde{r}_{t\to t+L}]^{-1} E[\tilde{r}_{t\to t+L}], \tag{15}$$

where $\tilde{r}_{t\to t+L}$ is a set of timing portfolios with scaled returns of liquid assets and L-period excess returns of illiquid assets scaled by the information set z_t.

The solution in (15) may produce a negative weight for illiquid assets. In reality, while shorting stocks and bonds is relatively easy, shorting illiquid assets is either too costly or impossible. For instance, investors cannot short hedge funds or transfer their stakes in hedge funds to other investors. In this case, investors should add nonnegative constraint on portfolio weights of illiquid assets to the analysis.

B. Econometric Issues

We estimate the set of portfolio weights in (15) by sample analogue. In addition, we can test whether state variables are jointly significant by a Wald test or F test. The construction of the estimated covariance matrix of $\tilde{w}$ and the test procedure follow the method by Britten-Jones (1999).

Given a time-series sample of asset returns, the estimation of $\tilde{w}$ can be sensitive to the choice of starting date of the sample. Specifically, for a lockup period of L, we have L choices of starting date, and the resulting L sets of the estimated $\tilde{w}$ are all consistent asymptotically. Following Jegadeesh and Titman (1993), and Rouwenhorst (1998), we consider L strategies that contribute equally to a composite portfolio. Specifically, at the start of each period, the composite portfolio consists of L sub-portfolios. Each sub-portfolio invests optimally according to one set of estimated $\tilde{w}$ on the basis of an estimation window. For example, suppose the lockup period is two-month and the sample data consists of ten-year monthly asset returns. We can estimate $\tilde{w}$ using two different windows: one starting one month later than another in the data. The composite portfolio invests one half according to the first set of estimated $\tilde{w}$ and one half according to the second set of estimated $\tilde{w}$. The method is comparable to that in Jegadeesh and Titman (1993), and Rouwenhorst (1998). In those two papers, they report the monthly average return of K strategies for K-month holding period in order to evaluate the relative strength portfolios.

III. Empirical Analysis

A. Data

For hedge funds, we obtain various hedge fund indexes and fund of funds indexes from Hedge Fund Research, Inc. (HFR, Inc.). A fund of funds or hedge fund of funds is a hedge fund that invests with multiple managers of hedge funds or managed accounts. Since a fund of funds holds a diversified portfolio of hedge funds, it lowers the risk of investing with an individual hedge fund manager and gives access to hedge funds that are closed to new money (Nicholas (2004)). The length of the lockup period depends on the liquidity of the underlying individual hedge funds in the fund of funds. Some funds of funds require no lockup periods, but a lockup period of 3 months up to 2 years is not uncommon. An individual U.S. hedge fund typically requires a one-year lockup period plus a notice period ranging from 1 month to 3 months. In contrast, less than 40 percent of funds of funds require a lockup period, and among those funds of funds that do, about two third of them set a lockup period of 6 month or longer (Nicholas (2004)). The HFRI Fund of Funds Composite Index (HFRIFoF) is an equally-weighted index that includes over 800 funds of hedge funds with at least USD 50 Million under management. Monthly returns are net of all fees. HFR, Inc. also provides four equally-weighted sub-indexes according to the classification of fund of funds strategies: Conservative, Diversified, Market Defensive, and Strategic. A fund of funds is classified as “Conservative” if it tends to invest in funds with conservative strategies such as Equity Market Neutral, Fixed Income Arbitrage, etc. that exhibit low historical volatilities. A fund of funds is “Diversified” if it invests with various strategies/managers and exhibits performance close to that of the HFRIFoF composite index. A “Market Defensive” fund of funds invests in funds with short-biased strategies and exhibits negative correlation with the equity market benchmark. Finally, a “Strategic” fund of funds tends to invest in hedge funds with more opportunistic strategies and exhibits greater volatility relative to the HFRIFoF composite index. For the composite index based on individual hedge funds, we use the HFRI Fund Weighted Composite Index (HFRI), which is an equally-weighted index based on more than 2000 individual hedge funds. Naturally, the HFRI index excludes funds of funds to prevent double counting of performance figures. In addition, HFR, Inc. classifies individual hedge funds into four primary strategies: Equity Hedge, Event-Driven, Macro, and Relative Value. Each primary strategy includes several sub-strategies. HFR, Inc. provides detailed descriptions of primary and sub-strategies in its products and website. From CRSP, we obtain the value-weighted NYSE index as the proxy for stocks, the 1-month Treasury bill as the proxy for the risk-free asset, and the Fama Bond Portfolio (Treasuries) with maturities greater than 10 years as the proxy for bonds. We construct quarterly returns from monthly index returns of stocks, bonds, and hedge funds. The relatively short sample period for the hedge fund data limits the empirical analysis to the sample period from December 1989 through December 2007. Table 1 gives summary statistics of risky asset returns.

Over the sample period, the average return and volatility of stocks is 11.4% and 12.6%, respectively. Bonds have an average return of 8.5% and volatility of 7.9%, but the Sharpe ratio of bonds is only slightly lower than that of stocks. The HFRIFoF composite index has a lower average return (9.7%) and volatility (5.5%) compared to stocks, and a Sharpe ratio of 1.033, which is almost twice as large as the Sharpe ratio of stocks or bonds. The HFRIFoF Conservative index has the lowest volatility among all fund of funds indexes, consistent with the style classification. The HFRIFoF Diversified index shows a similar average return and volatility compared to the composite index. Although average returns and volatilities differ among four HFRIFoF strategy indexes, their Sharpe ratios are not too far away from each other. In contrast, the HFRI Relative Value shows a Sharpe ratio that is higher than the other three HFRI strategy indexes and the HFRI composite index, mainly due to its low volatility. Furthermore, the average returns of the HFRI composite index and the HFRI strategy indexes are quite high compared to stocks, bonds and fund of funds indexes. The average return of the HFRI composite index is 13.2%, which is 3.5% higher than the average return of the HFRIFoF composite index, while the volatility of the HFRI composite index is about 6.6%, only 1.1% greater than that of the HFRIFoF composite index. The difference in Sharpe ratios of the two composite indexes is 0.35, so it seems that funds of funds offer lower risk-adjusted returns relative to the aggregate individual hedge funds. The double fees structure of fund of funds investments can account for some of the difference in risk-adjusted returns, but some researchers argue that the greater survivorship bias underlying individual hedge funds may cause the reported under-performance of funds of funds (See Fung and Hsieh (2000)).

We obtain the data of state variables from CRSP. We include two state variables that potentially help predict asset returns: the market dividend-price ratio and the short-term interest rate. For the short-term interest rate, the annualized 1-month Treasury bill is used. The market dividend price ratio is based on the value-weighted NYSE equity index, calculated as the ratio of sum of dividends over past twelve months to the NYSE index level. Many other state variables that potentially help predict asset returns are available, such as smooth earning-price ratio, consumption-wealth ratio, ROE, inflation, and potentially many others.[2] For equity returns, market dividend yields work reasonably well as a predictor, especially at long horizons (see, among others, Campbell and Viceira, (1999), (2002); Cochrane, (2007)). However, Ang and Bekaert (2007) argue that the predictive power of the dividend yield is not robust across sample periods or countries. A univariate dividend yield regression provides weak evidence of predictability when the 1990s bull market period is included. On the other hand, Ang and Bekaert (2007) find that the short rate is the most robust predictable variable for predicting excess returns at short horizons. Using both the short rate and dividend yield in regressions improves the fit, with the short rate dominating the dividend yield. Figure 1 plots the time series of state variables from December 1989 to December 2007. The market dividend price ratio is closely linked to the ups and downs of the U.S. stock market, so the long bull market in 1990s result in a downward trend of the dividend price ratio during this period. The short-term interest rate shows a pattern that is driven by the U.S. business cycle.

B. Unconditional Asset Allocation with a Three-Month Hedge Fund Lockup Period

Section B.1 reports the portfolio weights of the unconditional asset allocation with a three-month hedge fund lockup period. We are interested in the difference in the allocations to stocks and bonds when hedge funds are added to the portfolio, as well as the changes in investment patterns over the three-month investment horizon. We investigate the extent to which the total demand for stocks and bonds in the portfolio of stocks, bonds and hedge funds are caused by the speculative demand (Markowitz demand) and the hedge demand due to investments in hedge funds with a three-month lockup period. Section B.2 compares the performance of

2. Goyal and Welch (2007) and Campbell and Thompson (2007) include a comprehensive list of these variables along with some others as predictors used in predictability studies.

unconditional portfolios with various hedge fund indexes. The focus is to test the difference in Sharpe ratios of the three-asset portfolio with a lockup period and the portfolio without a lockup period. In addition, we can test whether adding hedge funds benefits improve the Sharpe ratio of the portfolio.

B.1. Portfolio Weights

Table 2 reports the results for the unconditional asset allocations with the three-month hedge fund lockup period. The degree of risk aversion of the investor is 10 for all analyses. The estimated parameters, portfolio performance and test statistics are the monthly averages of three-month rolling windows. We can think of this as the result of a strategy that always invests 1/3 of wealth for three months, starting every month, just as in jegadeesh and Titman (1993) and Rouwenhorst (1998) (see Section II.B. Econometric Issues). The t-statistics for the mean-variance portfolio weights are based on Britten-Jones (1999).

Results for the unconditional asset allocations in Table 2 show that portfolio weights vary in a systematic way over the investment horizon. The variation in unconditional portfolio weights is caused by the presence of timing portfolios. To start out, in the portfolio of stocks and bonds only, the allocations to stocks and bonds display distinct patterns over the investment horizon. Over the three months, the allocations to stocks decrease while the allocations to bonds increase. Thus, investors start with a relatively risky portfolio and gradually adjust their portfolio holdings in order to obtain a less risky portfolio by the end of their investment horizon. This is in line with life-cycle funds where equity exposure decreases over time, due to the autocorrelation in stock returns.

Adding hedge funds to the portfolio of stocks and bonds reduces the allocation to stocks and increases the allocation to bonds for each month, irrespective of whether or not a hedge fund lockup period exists. This reflects the fact that investing in hedge funds leads to bigger equity exposure relative to bond exposure. Adding hedge funds to the portfolio changes the pattern of portfolio weights of stocks over the investment horizon, while the pattern of portfolio weights of bonds remain monotonically increasing. For example, inclusion of the HFRIFoF to the portfolio of stocks and bonds will change pattern of investment in stocks over the three-month from being monotonically decreasing to being a hump shape, and inclusion of the HFRI will reverse the pattern to be monotonically increasing.

To further investigate these changes in the pattern of the portfolio weights of stocks, we calculate the Markowitz (or pure speculative) demands and the hedge demands for stocks and bonds in the three-asset portfolio with a hedge fund lockup period. Investing in a hedge fund when there is a lockup period, basically leads to an exogenously given exposure to the hedge fund after the first period, which may induce a hedge demand for stocks and bonds. The optimal investment in stocks and bonds in the three-asset portfolio is the sum of the Markowitz demands and the hedge demand. The Markowitz demand is the optimal portfolio weights of stocks and bonds when the investment menu includes stocks and bonds only. The hedge demand arises because the investor wants to hedge the changes in the value of hedge fund investment, which is locked up for three months. A negative hedge demand for stocks implies that the overall allocation to stocks will be lower than it would be in the portfolio consisting of only stocks and bonds.

Table 3 shows the optimal demand for stocks and bonds as the combination of the Markowitz demand [3] and the hedge demand, using either the HFRIFoF or the HFRI composite index as the proxy for hedge funds in the three-asset portfolio with lockup restriction. The hedge demand is the product of the optimal demand for hedge funds at time t and the slope coefficients from the regression of three-month excess returns of hedge funds on a constant and returns of the timing portfolios of stocks and bonds:

$$r^x_{t\to t+3} = \alpha + b_{s,1}\left(R^f_{t+1}R^f_{t+2}r^s_{t+1}\right) + b_{s,2}\left(R^f_t R^f_{t+2}r^s_{t+2}\right) + b_{s,3}\left(R^f_t R^f_{t+1}r^s_{t+3}\right)$$
$$+ b_{b,1}\left(R^f_{t+1}R^f_{t+2}r^b_{t+1}\right) + b_{b,2}\left(R^f_t R^f_{t+2}r^b_{t+2}\right) + b_{b,3}\left(R^f_t R^f_{t+1}r^b_{t+3}\right) + \varepsilon\,, \qquad (16)$$

We find that for each month, the hedge demand is negative for stocks and positive for bonds. Furthermore, the hedge demand for stocks is most negative in the beginning and increases over time, which results in a pattern of the optimal demands different from the Markowitz demands for stocks. For instance, adding the HFRIFoF to the portfolio gives rise to a small allocation to stocks relative to the Markowitz demand in the first month (19% vs. 60%). The Markowitz demand decreases to 58% in the second month, while the total demand increases to 30% due to an increase in the hedge demand. The total demand for stocks decreases to 27%, as the increase in the hedge demand is more than offset by the decrease in the Markowitz demand. For bond investment in the three-asset portfolio, the changes in portfolio weights are dominated by the

[3] The Markowitz demands for stocks and bonds in the three-asset allocation are the optimal allocations to stocks and bonds in the two-asset allocation, i.e. the portfolio weights of stocks and bonds in column 2 of Table 2. The difference between the total demands for stocks and bonds in the three-asset allocation (column 3 of Table 2) and the total demands for stocks and bonds in the two-asset allocation is the hedge demand.

changes in the Markowitz demands. The hedge demands for bonds are relatively small; the changes over the three-month horizon are not large enough to reverse the patterns of total investment in bonds.

The patterns of investment in stocks differ with different hedge fund indexes used as the proxy. Adding the HFRI to the portfolio leads to negative portfolio weights for stocks in all three months, and they monotonically increase from –57% in the first month to –31% in the last month. Adding the HFRI to the portfolio results in the allocation to hedge funds being almost twice as large as the allocation to hedge funds when the proxy for hedge funds is the HFRIFoF. Since the hedge demands for stocks and bonds depend on the allocation to hedge funds, and the covariance between stock/bond returns and hedge fund returns, they are larger (in absolute value or magnitude) in the portfolio of stocks, bonds and HFRI than those in the portfolio of stocks, bonds and HFRIFoF. In fact, the hedge demands are so much larger than the Markowitz demands for stocks when the HFRI is included in the portfolio that they lead to negative portfolio weights of stocks.

The patterns of investment in bonds, on the other hand, are similar. Adding either the HFRI or the HFRIFoF would not change the trend of investment in bonds. In all cases, total allocations to bonds increases over the three-month period. The hedge demands for bonds are larger in the portfolio of stocks, bonds and HFRI than those in the portfolio of stocks, bonds and HFRIFoF, simply because a large portfolio weight of the HFRI. However, the hedge demands are small relative to the Markowitz demands, and the variation in the hedge demands is not large enough to make a difference in the trend of total investment in bonds. For instance, the Markowitz demand for bonds is 55%, 74% and 98% in the first, second and third month. The corresponding hedge demand for bonds in the portfolio of stocks, bonds and HFRIFoF is 11%, 7% and 9% (24%, 13% and 27% in the portfolio of stocks, bonds and HFRI). The variation in the Markowitz demands over time is 19% from month 1 to month 2, and 24% from month 2 to month 3. In contrast, the variation in the hedge demands is less than 4% (14% in the portfolio of stocks, bonds and HFRI).

B.2. Portfolio Efficiency

An investor is interested in knowing the potential benefits from adding hedge funds to his portfolio. Table 4 reports the performance of unconditional portfolios of stocks, bonds and hedge funds. The p-values, as they appear in the table, are calculated based on the averaged test statistics over the three overlapping samples. In each case, a different hedge fund index is used as the proxy. The mean excess return and volatility of the two-asset portfolio is 8.1% and 8.9%, respectively. The three-asset portfolios with or without a lockup period have noticeably higher mean excess returns and volatilities. Moreover, the Sharpe ratios of the three-asset portfolios are much higher than the two-asset portfolio. The difference in mean returns, volatilities and Sharpe ratios of the three-asset portfolios is large when different hedge fund indexes are used. For instance, the portfolio of stocks, bonds and HFRIFoF with a lockup has a mean excess return of 14.8% with a volatility of 12.1%, compared to a mean excess return of 23.7% and a volatility of 15.3% for the portfolio of stocks, bonds and HFRI. The Sharpe ratio of the first portfolio above is 1.225, lower than the Sharpe ratio of 1.549 of the second portfolio.

The test of portfolio efficiency follows Jobson and Korkie (1982) and De Roon and Nijman (2001). Denote the sample Sharpe ratio for the benchmark portfolio r^p by $\hat{\theta}_p$, and the sample Sharpe ratio for the portfolio of test assets r and benchmark assets r^p jointly, by $\hat{\theta}$. The Wald statistic of the Sharpe ratio test is:

$$\xi_W = T\left(\frac{\hat{\theta}^2 - \hat{\theta}_p^2}{1+\hat{\theta}_p^2}\right) \sim \chi_K^2 \tag{17}$$

where T is the sample size and K is the degrees of freedom. The degrees of freedom are the difference in the number of parameters between the two asset allocations. From the p-values of the Sharpe ratio test in Table 4, the difference in Sharpe ratios between the two-asset portfolio and each three-asset portfolio is statistically significant at 1% level, indicating that the two-asset portfolio can be significantly improved upon by adding hedge funds.

An investor who ignores the existence of a hedge fund lockup period will get a wrong estimate of portfolio performance. From Table 2 and Table 3, we know that the existence of a three-month lockup period for hedge funds makes a difference in the allocations to stocks, bonds and hedge funds over the investment horizon. Assuming no hedge fund lockup period will produce a portfolio of stocks, bonds and hedge funds with a higher mean excess return and volatility, as well as a higher Sharpe ratio, relative to a portfolio of stocks, bonds and hedge funds with a lockup period of three months, regardless of the choice of a hedge fund proxy. As shown in Table 4, the difference in Sharpe ratios between the three-asset portfolio with hedge fund lockup period and the three-asset portfolio assuming no hedge fund lockup is large and statistically significant (except for the case when the HFRI Relative Value as the hedge fund proxy). For instance, the portfolio of stocks, bonds and HFRIFoF with a lockup has the Sharpe ratio of 1.225, but the Sharpe ratio is 1.533 if the three-month lockup period is ignored. The difference is statistically significant at 1% level. Similarly, for the portfolio of stocks, bonds and HFRI, the difference in Sharpe ratios is 0.233 (1.549 vs. 1.782). Hence, overlooking the existence of a hedge fund lockup period may overstate the performance of a three-asset portfolio.

C. Conditional Asset Allocation with a Three-Month Hedge Fund Lockup Period

This section reports the portfolio weights and performance of various conditional asset allocations. Asset allocations are conditional on a set of state variables, i.e. the market dividend price ratio and the short-term interest rate. We analyze the total demand for stocks and bonds in the conditional portfolio of stocks, bonds and hedge funds, as a combination of the speculative demand (Markowitz demand) and the hedge demand due to investments in hedge funds with a three-month lockup period, just like what we did in the previous subsection. We test the difference in Sharpe ratios of the three-asset portfolio with a lockup period and the portfolio without a lockup period. Furthermore, we test whether using conditional portfolio policy improves the efficiency of the unconditional portfolio.

C.1. Portfolio Decision Conditional on State Variables

Table 5 gives the correlation matrix for risky asset returns and lagged state variables. For most hedge fund indexes, their correlations to the market dividend price ratio or the short rate are stronger than the correlations of stocks and bonds to each of the two state variables. Notice that the correlation of stock returns to the HFRIFoF composite index returns is high, but lower than the correlation of stock returns to the HFRI composite index returns. This implies that the HFRIFoF is a better diversifier than the HFRI does. On the other hand, a high correlation of stock returns to hedge fund returns indicates that hedge funds and funds of funds have large equity exposures.

Table 6 reports the results of the conditional asset allocation. State variables are standardized so the intercepts are the average allocations over the sample period. The average allocations to stocks and bonds change as the time passes. For the two-asset allocation, the average allocations to stocks are not too different among three periods (97%, 93% and 110%), while the average allocation to bonds is 33% in the first month and increases sharply from 37% in month 2 to 100% in month 3. This implies that bonds become relatively important in the portfolio as the investment horizon approaches. In addition, for all three-asset portfolios, the average portfolio weights of bonds appear to be increasing over time and the increase is the largest from month 2 to month 3, a similar pattern to what we found for the two-asset portfolio.

The average allocations to stocks in the three-asset allocations with a three-month hedge fund lockup period increase over time. Table 7 shows the decomposition of the total demand for stocks and bonds as the combination of the Markowitz demand and the hedge demand. Adding the HFRIFoF to the portfolio induces an average hedge demand for stocks in the first month of -43%. The average hedge demand for stocks in the second or third month is close to zero. The average hedge demand for bonds in each month is negative, ranging from –38% in month 1 to –7% in month 3. It seems that adding the HFRIFoF to the portfolio suppresses the total allocations to stocks and bonds over the three-month horizon. However, the pattern and magnitude of average hedge demands when the HFRI is added to the portfolio is quite different. The average hedge demands for stocks are large and negative in each month (-171%, -128%, and –110%), dragging down the total demands for stocks in the three-asset portfolio. On the other hand, the average hedge demands for bonds are positive in each month (20%, 36%, and 55%). Hence, adding the HFRI to the portfolio leads to a sharp reduction in the allocations to stocks and an increase in the allocations to bonds over time.

Changes in state variables lead to changes in portfolio weights of conditional portfolios. The sign of coefficients on state variables in determining portfolio weights changes over time and across different portfolios. For instance, in the two-asset allocation, the change in the market dividend price ratio is positively related to the allocations to stocks in the first and third month, but not in the second month. The change in the short rate is negatively related to the allocations to stocks in the first and third month, but is positively related in the second month. Such changes in signs over time exist for other portfolios. For three-asset portfolios, the signs of coefficients on both state variables in determining bonds weights show consistency over the three periods. Moreover, at a given month, the sign and magnitude of the slope coefficients on state variables is different across different portfolios. Therefore, the investor’s response to changes in state variables will depend on whether hedge funds are added to the portfolio, which hedge fund index is used as the proxy, and which month the investment decision is made.

C.2. Conditional Allocation vs. Unconditional Allocation

A comparison of the conditional asset allocation and the unconditional asset allocation reveals some interesting results. Relative to the unconditional two-asset allocation, the conditional portfolio allocates more to stocks in every period. This reflects the possibility of portfolio adjustment in response to changing market conditions. In addition, the conditional two-asset portfolio allocates less to bonds in the first two months and more in the third month, compared to the unconditional asset allocation to bonds in the same periods. It appears that the ability to adjust portfolio weights according to changes in state variables induces the investor to allocate more aggressively to stocks and less to bonds overall.

When the conditional portfolios include hedge funds with a three-month lockup period, the average allocations to hedge funds become larger compared to the unconditional allocations to hedge funds. While the hedge demands for stocks in the portfolio of stocks, bonds and HFRIFoF reduce the total demands for stocks under the unconditional asset allocation in every period, the average hedge demand for stocks is close to zero in the second and third month under the conditional asset allocation. Furthermore, the average hedge demands for bonds become negative for the conditional three-asset portfolio, in contrast with the positive hedge demands in the unconditional portfolio. Adding the HFRI to the conditional portfolio tells a different story. Even though the average Markowitz demand for stocks is higher in the conditional portfolio, the average hedge demand for stocks in each period is more negative in the conditional portfolio (-171%, -128%, and -110%). The net effect is that the conditional portfolio has lower average allocations to stocks in the first month, but higher in the remaining two periods. The average hedge demands for bonds are positive and much larger than the hedge demands for bonds in the unconditional portfolio in the second month (36% vs. 13%) and the third month (55% vs. 27%).

C.3. Portfolio Efficiency

Table 8 shows the performance of conditional portfolios using different hedge fund indexes as the proxy for investments in hedge funds. It also reports the results of the Wald test of the null hypothesis that all slope coefficients of the market dividend price ratio and the short-term interest rate are jointly equal to zero. Four questions arise. First of all, is the conditional two-asset portfolio mean-variance efficient or does adding hedge funds to the conditional portfolio improve the portfolio efficiency? Second, is the unconditional portfolios mean-variance efficient? Third, is it possible that while the changes in state variables help adjustment in portfolio weights of stocks, bonds and hedge funds, the investor does not benefit from using those state variables in terms of the portfolio performance? Finally, what difference does a three-month hedge fund lockup period make in terms of the portfolio performance?

We can use the Sharpe ratio test to determine the portfolio efficiency of the conditional two-asset allocation relative to the three-asset allocation, and the unconditional portfolios relative to the conditional portfolios. Ten different hedge fund indexes are used as the proxy for hedge funds, including four strategy indexes for HFRI fund of funds, and four strategy indexes for HFRI hedge funds. For each case, we have p-values from four Sharpe ratio tests. For instance, using the HFRIFoF composite index as the proxy, the Sharpe ratio of the conditional three-asset portfolio with a lockup period and without a lockup period is 1.873 and 2.158, respectively. The p-value (0.001) to the right of the Sharpe ratio of the conditional three-asset with a lockup period is based on the Sharpe ratio test of the conditional two-asset allocation as the benchmark portfolio (i.e. we test the conditional two-asset portfolio vs. the conditional three-asset portfolio with a lockup period). The p-value (0.087) next to the Sharpe ratio of the conditional three-asset without a lockup period is based on the Sharpe ratio test of the difference in Sharpe ratios of two conditional three-asset portfolios, i.e. the portfolio with a lockup period vs. the portfolio without a lockup period. The p-value (0.021) and (0.084) under the Sharpe ratio of the conditional three-asset portfolio with a lockup period and the conditional three-asset portfolio without a lockup period are based on the Sharpe ratio test of the unconditional portfolios vs. conditional portfolios, with or without a lockup period, respectively.

For all cases, the difference in Sharpe ratios of the conditional three-asset portfolio with a three-month lockup period and the conditional two-asset portfolio is significant at the 5% significance level (the difference is significant at the 1% level for 9 out of 10 cases). Thus, we conclude that the conditional portfolio of stocks and bonds only is not mean-variance efficient.

The investor should add hedge funds to the portfolio even though there is a lockup period of three months.

The two p-values under the Sharpe ratios of three-asset portfolios come from the Sharpe ratio test of the unconditional asset allocation vs. the conditional asset allocation, with and without a three-month lockup period. For the three-asset portfolios with a lockup period and using any fund of funds index, the Sharpe ratio of the conditional portfolio is significantly larger than the unconditional portfolio at the 5% level. Adding the HFRI or the HFRI strategy index to the portfolio, the difference in the Sharpe ratios is significant at the 5% level in one case (when using HFRI Relative Value as the proxy). When no lockup period is assumed, the difference in the Sharpe ratios of the conditional three-asset portfolio and the unconditional three-asset portfolio is significantly at the 5% level for 3 out of 10 cases.

Interestingly, we can reject the null hypothesis that all slope coefficients of the market dividend price ratio and the short-term interest rate are jointly equal to zero at the 1% significance level for all conditional portfolios, on the basis of the p-values of the Wald test in Table 8. In other words, changes in state variables lead to significant changes in portfolio weights of risky assets, and yet the conditional portfolios are not necessarily better than the unconditional portfolios in terms of portfolio performance. From the Sharpe ratio test of the unconditional portfolio vs. the conditional portfolio above, for many unconditional three-asset portfolios, we cannot reject their efficiency.

To answer the last question, we perform the Sharpe ratio test of the conditional three-asset allocation with a three-month hedge fund lockup period against the conditional three-asset allocation assuming no lockup period, in order to assess the effect of a hedge fund lockup on portfolio efficiency under conditional information. When the HFRIFoF and four HFRIFoF strategy indexes are considered as the proxy for hedge funds, the difference in the Sharpe ratios of the three-asset portfolios with a lockup period and the three-asset portfolio without a lockup period is not significant for 4 cases. The difference is significant at the 5% level only when the HFRIFoF Conservative is used as the hedge fund proxy in the three-asset portfolio. When the HFRI composite index or the HFRI strategy index is used as the proxy for hedge funds, the difference is much larger and significant at the 5% level regardless of the choice of hedge fund proxy. Therefore, having a three-month lockup period implies a significant lower Sharpe ratio of the three-asset portfolio of stocks, bonds, HFRI (or HFRI strategy).

As the results of the Sharpe ratio test indicate, a three-month lockup period is less likely to affect the performance of the three-asset portfolios of stocks, bonds and funds of funds. Funds of funds seem to be better able to suppress the effect of lockup periods on conditional portfolios' performance than individual hedge funds do. Possible explanations which require further research include: a fund of funds typically has more frequent subscriptions and can use new money to pay off redemption requests. Moreover, a fund of funds manager can actively manage the lockup periods of the underlying individual hedge funds, such that each fund has a different lockup expiration date. In this way, a fund of funds can still invest in many individual hedge funds with long lockup periods, while imposes a shorter lockup period for fund of funds investors. From a conditional portfolio investor's perspective, when he decides to add funds of funds to the portfolio of stocks and bonds, a three-month hedge fund lockup period should not cause great concerns on the basis of portfolio outcomes. In contrast, a conditional portfolio investor who tries to add individual hedge funds to the portfolio should not overlook the effect of a three-month lockup period on the portfolio performance. He would get a wrong impression of the incremental benefits of investing in hedge funds if he ignores the existence of a lockup period.

D. Bootstrap Samples with a One-Year Hedge Fund Lockup Period

Three-month hedge fund lockup period is plausible for many funds of funds, but some funds and funds and individual hedge funds have longer lockup periods. The estimation is problematic with longer lockup periods since the history of hedge fund indexes is relatively short. For instance, for the one-year horizon, we have only 18 non-overlapping samples to estimate parameters of interest whose number can be more than 70. Using quarterly returns or fewer state variables will reduce the number of parameters, without decreasing the sample size. We use the bootstrap method to obtain a larger sample size in order to examine the effect of a long lockup period.

We follow the stationary bootstrap method by Politis and Romano (1993) and Sullivan, Timmermann and White (1999) to obtain 5000 bootstrap samples of quarterly data. The smoothing parameter is chosen to be 0.2, so the mean block length is 5. The choice of the smoothing parameter affects the portfolio weights and performance, but the results of the Sharpe ratio rest and the Wald test are not too sensitive to the smoothing parameter.

Table 9 gives the results of unconditional portfolio performance, using various hedge fund indexes as proxy for hedge funds. The significantly higher Sharpe ratios for three-asset portfolios justify the inclusion of hedge funds into an investors' portfolio. Nevertheless, a one-year lockup period seems to make little impact on the performance of unconditional three-asset portfolios of stocks, bonds and HFRIFoF (or HFRIFoF strategy), as the difference in Sharpe ratios of the portfolios with or without a lockup period is not significant. Adding the HFRI or HFRI strategy indexes to the portfolio also increases the Sharpe ratio significantly. However, having a one-year lockup period causes the difference in the Sharpe ratios of the three-asset portfolios when the HFRI Event-Driven or the HFRI Relative Value is used as the hedge fund proxy.

Table 10 reports the analysis of the conditional asset allocation. The changes in the market dividend yield affect portfolio weights of risky assets in a significant way. All p-values are equal to zero, for the Wald test of the null hypothesis that all slope coefficients are jointly equal to zero. In addition, the Sharpe ratios are significantly higher under the conditional portfolios than those under the unconditional portfolios in all cases. Therefore, an investor can benefit from using conditional information in the portfolio decision. Relative to the two-asset conditional portfolio, adding hedge funds to the portfolios improve the portfolio payoff in terms of Sharpe ratios. However, a conditional portfolio investor would overestimate the portfolio performance when he ignores the presence of one-year hedge fund lockup period. A one-year lockup period has significant impact on the portfolio performance whichever hedge fund index is chosen as the proxy. It seems that if the lockup period is long, an investor should be concerned with the effect of a lockup period on the performance of his portfolio, for investments in funds of funds as well as individual hedge funds.

IV. Conclusion

A lockup period is a realistic feature of investments in hedge funds, private equities and venture capital. This paper considers the impact of hedge fund lockup periods on the asset allocation decisions of a mean-variance investor who re-adjusts the portfolio periodically. Due to the presence of a hedge fund lockup period, the investor can only adjust the allocation of stocks and bonds. The mean-variance framework in this paper serves to illustrate the effect of hedge fund lockup periods on multi-period asset allocation, with the potential to extend to other asset classes with similar lockup or illiquid constraints. The empirical analysis indicates that the investor is better off by investing in portfolios of stocks, bonds and hedge funds, relative to a portfolio of stocks and bonds. In addition, the unconditional asset allocations seem to be inefficient. The conditional asset allocation can achieve better outcomes in terms of Sharpe ratios than the unconditional asset allocation. Nevertheless, even though the changes in the state variables such as the market dividend price ratio and the short rate help predict portfolio weights, a conditional portfolio is not necessarily better than its unconditional counterpart in terms of the portfolio performance. Most importantly, the presence of a lockup period is not trivial, especially when investing in a portfolio of individual hedge funds. An investor may overstate the benefit from adding hedge funds to a portfolio when he overlooks the existence of a hedge fund lockup period. Nevertheless, funds of funds seem to be able to suppress the effect of a short lockup period on the performance of conditional portfolios and the effect of a long lockup period on the performance of unconditional portfolios.

Table 1
Descriptive Statistics of Risky Asset Returns

This table gives summary statistics of risky assets from January 1990 to December 2007. The value-weighted NYSE index is proxy for stocks, and Fama Bond Portfolio (Treasuries) with maturities greater than 10 years is proxy for bonds. For hedge funds, various indexes are considered: HFRI Fund of Funds composite index (HFRIFoF), HFRIFoF sub-strategy indexes, HFRI Fund Weighted Composite Index (HFRI) and HFRI sub-strategy indexes. Means, standard deviations, maximums and minimums are expressed in percentages. We annualize means, standard deviations and Sharpe ratios, while the remaining statistics are on a monthly basis.

	Mean	Std	Sharpe	Max	Min	Skew	Kurtosis
Stocks	11.4%	12.6%	0.581	10.7%	-14.7%	-0.531	1.347
Bonds	8.5%	7.9%	0.563	7.2%	-8.3%	-0.430	0.845
HFRIFoF	9.7%	5.5%	1.033	6.9%	-7.5%	-0.284	4.049
-Conservative	8.3%	3.2%	1.332	4.0%	-3.9%	-0.506	3.144
-Diversified	9.1%	5.8%	0.870	7.7%	-7.8%	-0.134	4.182
-Market Defensive	9.4%	5.8%	0.939	7.4%	-5.4%	0.148	1.234
-Strategic	12.7%	8.6%	1.010	9.5%	-12.1%	-0.389	3.827
HFRI	13.2%	6.6%	1.383	7.7%	-8.7%	-0.590	2.940
-Equity Hedge	15.7%	8.5%	1.376	10.9%	-7.7%	0.193	1.551
-Event-Driven	13.5%	6.4%	1.475	5.1%	-8.9%	-1.251	4.630
-Macro	14.3%	8.0%	1.295	7.9%	-6.4%	0.394	0.784
-Relative Value	11.2%	3.5%	2.079	5.7%	-5.8%	-0.804	10.433

Table 2
Unconditional Asset Allocation
(Lockup: Three-month)

This table reports the results of unconditional asset allocations for the degree of risk aversion of the investor, $\gamma = 10$. The data frequency is monthly. Column 2 to 4 show optimal unconditional weights for various portfolios at each month using the HFRIFoF composite index as the proxy for hedge funds. Column 5 to 6 show optimal unconditional weights for various portfolios at each month using the HFRI composite index as the proxy for hedge funds. Absolute values of t-statistics for the portfolio weights are in parentheses.

			HFRIFoF as Hedge Fund Proxy				HFRI as Hedge Fund Proxy			
Period	**Two-Asset**		**Three-Asset with Lockup**		**Three-Asset without Lockup**		**Three-Asset with Lockup**		**Three-Asset without Lockup**	
Stocks										
Month 1	0.601	(1.812)	0.194	(0.577)	0.017	(0.627)	-0.572	(1.462)	-1.071	(2.384)
Month 2	0.577	(1.741)	0.304	(0.888)	0.504	(2.087)	-0.449	(1.675)	-0.104	(1.974)
Month 3	0.426	(1.260)	0.271	(0.96)	0.418	(2.063)	-0.311	(1.052)	0.258	(2.531)
Bonds										
Month 1	0.547	(1.005)	0.653	(1.205)	0.771	(1.436)	0.781	(1.480)	0.831	(1.602)
Month 2	0.743	(1.399)	0.817	(1.542)	0.894	(1.704)	0.875	(1.696)	0.981	(1.934)
Month 3	0.981	(1.824)	1.072	(2.009)	1.121	(2.112)	1.252	(2.401)	1.392	(2.694)
Hedge Funds										
Month 1			1.378	(3.672)	2.436	(2.845)	2.292	(6.264)	3.950	(4.463)
Month 2					1.157	(2.506)			2.142	(2.316)
Month 3					0.715	(2.488)			1.173	(2.614)

Table 3
Hedge Demands for Stocks and Bonds under Unconditional Asset Allocation
(Lockup: Three-month)

This table displays, for the unconditional three-asset allocation with a three-month hedge fund lockup period, the decomposition of portfolio weights of stocks and bonds at each month into two parts: a Markowitz demand or speculative demand and a hedge demand. Absolute values of t-statistics for those portfolio weights are in parentheses.

	Markowitz Demand (M)		**Hedge Demand (H)**		**Optimal Demand = M + H**	
HFRIFoF as Hedge Fund proxy:						
Stocks						
Month 1	0.601	(1.812)	-0.408	(2.912)	0.194	(0.627)
Month 2	0.578	(1.741)	-0.273	(1.943)	0.304	(2.087)
Month 3	0.426	(1.260)	-0.155	(1.063)	0.271	(2.063)
Bonds						
Month 1	0.547	(1.005)	0.106	(0.465)	0.653	(1.436)
Month 2	0.743	(1.399)	0.074	(0.347)	0.817	(1.704)
Month 3	0.981	(1.824)	0.091	(0.432)	1.072	(2.112)
HFRI as Hedge Fund proxy:						
Stocks						
Month 1	0.601	(1.812)	-1.174	(5.355)	-0.572	(2.384)
Month 2	0.578	(1.741)	-1.026	(4.702)	-0.449	(1.974)
Month 3	0.426	(1.260)	-0.737	(3.319)	-0.311	(2.531)
Bonds						
Month 1	0.547	(1.005)	0.235	(0.643)	0.781	(1.602)
Month 2	0.743	(1.399)	0.132	(0.431)	0.875	(1.934)
Month 3	0.981	(1.824)	0.271	(0.785)	1.252	(2.694)

Table 4
Performance of the Unconditional Portfolios
(Lockup: Three-month)

This table reports performance of unconditional portfolios of stocks, bonds and hedge funds. There are ten hedge fund indexes that are considered one at a time as the proxy for hedge funds. Mean returns, standard deviations and Sharpe ratios are annualized. We report p-values of Sharpe ratio tests. The benchmark portfolio in each case is the portfolio to the left of the portfolio where a p-value appears in parenthesis next to the portfolio's Sharpe ratio. The data frequency is monthly.

	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup
Hedge Fund Proxy:		**HFRIFoF Composite Index**			**HFRI Composite Index**	
Mean excess returns	8.1%	14.8%	23.3%	8.1%	23.7%	31.4%
Std. excess returns	8.9%	12.1%	15.2%	8.9%	15.3%	17.6%
Sharpe ratio	0.907	1.225 (0.001)	1.533 (0.004)	0.907	1.549 (0.000)	1.782 (0.012)
Hedge Fund Proxy:		**HFRIFoF Cnservative**			**HFRI Equity Hedge**	
Mean excess returns	8.1%	19.0%	26.1%	8.1%	25.0%	32.5%
Std. excess returns	8.9%	13.7%	16.1%	8.9%	15.7%	17.9%
Sharpe ratio	0.907	1.389 (0.000)	1.622 (0.014)	0.907	1.591 (0.000)	1.814 (0.015)
Hedge Fund Proxy:		**HFRIFoF Diversified**			**HFRI Event-Driven**	
Mean excess returns	8.1%	13.1%	19.0%	8.1%	28.5%	35.6%
Std. excess returns	8.9%	11.4%	13.7%	8.9%	16.8%	18.7%
Sharpe ratio	0.907	1.153 (0.006)	1.384 (0.019)	0.907	1.694 (0.000)	1.893 (0.023)
Hedge Fund Proxy:		**HFRIFoF Market Defensive**			**HFRI Macro**	
Mean excess returns	8.1%	17.1%	23.5%	8.1%	17.1%	21.7%
Std. excess returns	8.9%	13.0%	15.2%	8.9%	13.0%	14.6%
Sharpe ratio	0.907	1.317 (0.000)	1.540 (0.018)	0.907	1.314 (0.000)	1.481 (0.054)
Hedge Fund Proxy:		**HFRIFoF Strategic**			**HFRI Relative Value**	
Mean excess returns	8.1%	14.2%	20.3%	8.1%	39.3%	42.9%
Std. excess returns	8.9%	11.8%	14.1%	8.9%	19.7%	20.6%
Sharpe ratio	0.907	1.201 (0.002)	1.434 (0.017)	0.907	1.994 (0.000)	2.083 (0.195)

Table 5
Correlation Matrix of State Variables and Asset Returns

This table displays the correlation matrix of lagged state variables and risky asset returns from January 1990 to December 2007. The data frequency is monthly. State variables include the market dividend price ratio and the short-term interest rate.

	Dividend price ratio	Short rate	Stocks	Bonds	HFRIFoF composite	FoF Conservative	FoF Diversified	FoF Market defensive	FoF Strategic	HFRI composite	Equity Hedge	Event-Driven	Macro	Relative Value
Dividend price ratio	1													
Short rate	0.35	1												
Stocks	0.08	0.04	1											
Bonds	0.05	0.05	0.05	1										
HFRIFoF composite	0.12	0.07	0.43	0.02	1									
FoF Conservative	0.13	0.14	0.44	0.05	0.89	1								
FoF Diversified	0.10	0.05	0.43	0	0.97	0.84	1							
FoF Market Defensive	0.07	0.15	0.04	0.11	0.69	0.62	0.63	1						
FoF Strategic	0.19	0.08	0.48	0.01	0.93	0.82	0.87	0.55	1					
HFRI composite	0.14	0.03	0.69	-0.01	0.83	0.74	0.81	0.35	0.85	1				
Equity Hedge	0.13	0.12	0.64	0	0.77	0.69	0.75	0.35	0.80	0.93	1			
Event-Driven	0.08	-0.01	0.67	-0.03	0.67	0.62	0.65	0.26	0.70	0.88	0.78	1		
Macro	0.21	0.02	0.40	0.28	0.72	0.64	0.71	0.52	0.68	0.69	0.61	0.56	1	
Relative Value	0.20	0.16	0.39	-0.03	0.53	0.54	0.51	0.27	0.53	0.63	0.55	0.65	0.41	1

Table 6
Conditional Asset Allocation
(Lockup: Three-month; State Variables: Dividend Price Ratio and Short Rate)

This table reports the results of conditional asset allocations for the degree of risk aversion of the investor, $\gamma = 10$. The data frequency is monthly. Column 3 to 5 show intercepts and coefficients of state variables by which optimal conditional weights for various portfolios are determined using the HFRIFoF composite index as the proxy for hedge funds. Column 6 to 7 show intercepts and coefficients of state variables by which optimal conditional weights for various portfolios are determined using the HFRI composite index as the proxy for hedge funds. Absolute values of t-statistics for the intercepts and coefficients are in parentheses.

				HFRIFoF as Hedge Fund Proxy				HFRI as the Hedge Fund Proxy			
Period	**State Variables**	**Two Asset**		**Three Asset with Lockup**		**Three-Asset without Lockup**		**Three Asset with Lockup**		**Three-Asset without Lockup**	
Stocks											
Month 1	Constant	0.972	(2.323)	0.543	(1.169)	0.173	(2.002)	-0.739	(1.425)	-1.528	(2.347)
	DP ratio	0.011	(2.405)	-0.010	(2.141)	0.216	(1.538)	-0.907	(2.430)	0.201	(1.419)
	T-Bill	-0.274	(2.389)	-0.112	(2.926)	-0.405	(2.746)	0.625	(2.309)	0.504	(1.017)
Month 2	Constant	0.927	(2.241)	0.928	(2.049)	1.498	(2.841)	-0.350	(0.755)	0.342	(2.220)
	DP ratio	-0.058	(1.732)	0.236	(1.170)	-0.113	(0.938)	-0.754	(2.203)	-0.843	(1.147)
	T-Bill	0.421	(2.323)	0.642	(2.441)	0.868	(3.208)	0.963	(2.530)	2.294	(2.895)
Month 3	Constant	1.096	(2.607)	1.096	(2.454)	1.242	(3.319)	0.000	(1.706)	0.865	(3.696)
	DP ratio	0.334	(1.879)	0.793	(2.260)	0.505	(1.175)	0.130	(0.806)	0.279	(1.246)
	T-Bill	-0.052	(1.378)	0.084	(1.326)	0.116	(1.589)	0.354	(1.530)	0.441	(1.098)
Bonds											
Month 1	Constant	0.325	(0.486)	-0.050	(0.624)	0.040	(1.151)	0.521	(0.806)	0.522	(0.744)
	DP ratio	0.239	(1.522)	-0.487	(0.553)	-0.322	(0.565)	-0.301	(0.734)	-0.766	(0.877)
	T-Bill	-0.577	(0.948)	0.126	(0.433)	0.109	(0.608)	0.500	(0.794)	0.701	(1.274)
Month 2	Constant	0.368	(0.535)	0.051	(1.507)	0.234	(2.140)	0.726	(1.195)	0.648	(0.901)
	DP ratio	0.351	(2.369)	-0.342	(1.066)	-0.882	(1.273)	-0.445	(1.644)	-1.215	(2.307)
	T-Bill	-0.148	(0.701)	0.122	(0.894)	0.368	(0.985)	0.519	(0.784)	0.725	(1.083)
Month 3	Constant	1.002	(1.471)	0.931	(1.317)	1.444	(1.949)	1.550	(2.266)	2.168	(3.012)
	DP ratio	-0.662	(2.194)	-1.453	(1.557)	-1.823	(1.884)	-1.221	(1.811)	-1.187	(1.301)
	T-Bill	0.128	(0.368)	0.668	(0.907)	0.861	(1.143)	1.079	(1.507)	1.158	(1.555)
Hedge Funds											
Month 1	Constant			2.293	(4.580)	4.040	(3.734)	3.072	(6.741)	6.164	(4.783)
	DP ratio			1.639	(3.488)	0.225	(0.269)	0.885	(2.184)	-1.383	(1.179)
	T-Bill			-0.160	(0.755)	0.435	(0.618)	-1.210	(2.135)	-0.891	(1.178)
Month 2	Constant					1.120	(2.437)			3.198	(2.248)
	DP ratio					1.468	(1.193)			1.249	(0.927)
	T-Bill					-0.137	(0.711)			-3.259	(1.893)
Month 3	Constant					2.013	(2.276)			1.626	(2.732)
	DP ratio					2.366	(1.913)			0.415	(0.959)
	T-Bill					-1.120	(0.969)			-1.838	(1.111)

Table 7
Average Hedge Demands for Stocks and Bonds under Conditional Asset Allocation
(Lockup: Three-month; State Variables: Dividend Price Ratio and Short Rate)

This table displays, for the conditional three-asset allocation with a three-month hedge fund lockup period, the decomposition of average portfolio weights of stocks and bonds at each month into two parts: a Markowitz demand or speculative demand and a hedge demand. Absolute values of t-statistics for those portfolio weights are in parentheses.

	Markowitz Demand (M)		Hedge Demand (H)		Optimal Demand = M + H	
HFRIFoF as Hedge Fund proxy:						
Stocks						
Month 1	0.972	(2.323)	-0.429	(2.158)	0.543	(1.169)
Month 2	0.927	(2.241)	0.001	(1.397)	0.928	(2.049)
Month 3	1.096	(2.607)	0.000	(1.020)	1.096	(2.454)
Bonds						
Month 1	0.325	(0.486)	-0.375	(0.555)	-0.050	(0.624)
Month 2	0.368	(0.535)	-0.317	(0.563)	0.051	(1.507)
Month 3	1.002	(1.471)	-0.071	(0.421)	0.931	(1.317)
HFRI as Hedge Fund proxy:						
Stocks						
Month 1	0.972	(2.323)	-1.711	(4.495)	-0.739	(1.425)
Month 2	0.927	(2.241)	-1.277	(3.901)	-0.350	(0.755)
Month 3	1.096	(2.607)	-1.096	(3.080)	0.000	(1.706)
Bonds						
Month 1	0.325	(0.486)	0.196	(1.077)	0.521	(0.806)
Month 2	0.368	(0.535)	0.359	(1.067)	0.726	(1.195)
Month 3	1.002	(1.471)	0.548	(1.004)	1.550	(2.266)

Table 8
Performance of the Conditional Portfolios
(Lockup: Three-month; State Variables: Dividend Price Ratio and Short Rate)

This table reports performance of conditional portfolios of stocks, bonds and hedge funds. There are ten hedge fund indexes that are considered one at a time as the proxy for hedge funds. Mean returns, standard deviations and Sharpe ratios are annualized. We report p-values of Sharpe ratio tests. For each three-asset portfolio, two p-values are reported using two benchmark portfolios. The p-value appears in parenthesis next to the portfolio's Sharpe ratio uses the portfolio to the left as the benchmark portfolio, where the second p-value below the first p-value uses the corresponding unconditional portfolio with the same set of assets and lockup assumption as the benchmark portfolio. In addition, the table reports the p-values of the Wald test under the null hypothesis that all slope coefficients are jointly equal to zero. The data frequency is monthly.

	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup
Hedge Fund Proxy:		**HFRIFoF Composite Index**			**HFRI Composite Index**	
Mean excess returns	22.0%	35.2%	46.6%	22.0%	42.3%	57.6%
Std. excess returns	14.7%	18.7%	21.3%	14.7%	20.4%	23.8%
Sharpe ratio	1.474	1.873 (0.001)	2.158 (0.087)	1.474	2.057 (0.000)	2.403 (0.035)
Unconditional vs. Conditional		(0.021)	(0.084)		(0.102)	(0.092)
Wald test of slope coefficients	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Conservative**			**HFRI Equity Hedge**	
Mean excess returns	22.0%	39.6%	54.1%	22.0%	40.9%	57.7%
Std. excess returns	14.7%	19.7%	23.1%	14.7%	20.1%	23.8%
Sharpe ratio	1.474	1.982 (0.000)	2.335 (0.030)	1.474	2.016 (0.000)	2.407 (0.017)
Unconditional vs. Conditional		(0.037)	(0.030)		(0.241)	(0.127)
Wald test of slope coefficients	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Diversified**			**HFRI Event-Driven**	
Mean excess returns	22.0%	33.0%	42.1%	22.0%	50.3%	70.4%
Std. excess returns	14.7%	18.0%	20.3%	14.7%	22.4%	26.4%
Sharpe ratio	1.474	1.806 (0.005)	2.050 (0.158)	1.474	2.237 (0.000)	2.665 (0.009)
Unconditional vs. Conditional		(0.022)	(0.055)		(0.066)	(0.014)
Wald test of slope coefficients	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Market Defensive**			**HFRI Macro**	
Mean excess returns	22.0%	37.0%	44.2%	22.0%	30.4%	43.7%
Std. excess returns	14.7%	19.1%	20.8%	14.7%	17.3%	20.7%
Sharpe ratio	1.474	1.923 (0.001)	2.103 (0.344)	1.474	1.741 (0.019)	2.095 (0.031)
Unconditional vs. Conditional		(0.033)	(0.164)		(0.278)	(0.103)
Wald test of slope coefficients	(0.001)	(0.000)	(0.000)	(0.001)	(0.006)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Strategic**			**HFRI Relative Value**	
Mean excess returns	22.0%	34.1%	44.3%	22.0%	66.2%	85.0%
Std. excess returns	14.7%	18.4%	20.8%	14.7%	25.6%	29.0%
Sharpe ratio	1.474	1.846 (0.002)	2.100 (0.132)	1.474	2.575 (0.000)	2.926 (0.040)
Unconditional vs. Conditional		(0.024)	(0.058)		(0.044)	(0.006)
Wald test of slope coefficients	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)

Table 9
Performance of the Unconditional Portfolios
(Lockup: One-year; 5000 Bootstrap Samples)

This table reports performance of unconditional portfolios of stocks, bonds and hedge funds. There are ten hedge fund indexes that are considered one at a time as the proxy for hedge funds. Mean returns, standard deviations and Sharpe ratios are annualized. We report p-values of Sharpe ratio tests. The benchmark portfolio in each case is the portfolio to the left of the portfolio where a p-value appears in parenthesis next to the portfolio's Sharpe ratio. The data frequency is quarterly. The number of bootstrap sample is 5000.

	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup
Hedge Fund Proxy:		**HFRIFoF Composite Index**			**HFRI Composite Index**	
Mean excess returns	11.0%	15.4%	18.0%	11.0%	22.0%	25.7%
Std. excess returns	13.5%	12.3%	13.3%	13.5%	14.7%	15.9%
Sharpe ratio	0.824	1.225 (0.000)	1.324 (0.138)	0.824	1.469 (0.000)	1.588 (0.102)
Hedge Fund Proxy:		**HFRIFoF Conservative**			**HFRI Equity Hedge**	
Mean excess returns	11.0%	17.0%	19.7%	11.0%	20.8%	23.9%
Std. excess returns	13.5%	12.9%	13.9%	13.5%	14.3%	15.3%
Sharpe ratio	0.824	1.287 (0.000)	1.385 (0.148)	0.824	1.428 (0.000)	1.531 (0.143)
Hedge Fund Proxy:		**HFRIFoF Diversified**			**HFRI Event-Driven**	
Mean excess returns	11.0%	14.7%	17.3%	11.0%	28.1%	34.1%
Std. excess returns	13.5%	12.0%	13.0%	13.5%	16.6%	18.3%
Sharpe ratio	0.824	1.195 (0.000)	1.295 (0.133)	0.824	1.661 (0.000)	1.828 (0.038)
Hedge Fund Proxy:		**HFRIFoF Market Defensive**			**HFRI Macro**	
Mean excess returns	11.0%	22.2%	25.8%	11.0%	15.2%	18.1%
Std. excess returns	13.5%	14.8%	15.9%	13.5%	12.2%	13.3%
Sharpe ratio	0.824	1.475 (0.000)	1.587 (0.115)	0.824	1.222 (0.000)	1.331 (0.108)
Hedge Fund Proxy:		**HFRIFoF Strategic**			**HFRI Relative Value**	
Mean excess returns	11.0%	13.9%	16.2%	11.0%	30.3%	36.8%
Std. excess returns	13.5%	11.6%	12.6%	13.5%	17.3%	19.1%
Sharpe ratio	0.824	1.164 (0.000)	1.255 (0.164)	0.824	1.727 (0.000)	1.900 (0.034)

Table 10
Performance of the Conditional Portfolios
(Lockup: One-year; State Variable: Dividend Price Ratio; 5000 Bootstrap Samples)

This table reports performance of conditional portfolios of stocks, bonds and hedge funds. There are ten hedge fund indexes that are considered one at a time as the proxy for hedge funds. Mean returns, standard deviations and Sharpe ratios are annualized. We report p-values of Sharpe ratio tests. For each three-asset portfolio, two p-values are reported using two benchmark portfolios. The p-value appears in parenthesis next to the portfolio's Sharpe ratio uses the portfolio to the left as the benchmark portfolio, where the second p-value below the first p-value uses the corresponding unconditional portfolio with the same set of assets and lockup assumption as the benchmark portfolio. In addition, the table reports the p-values of the Wald test under the null hypothesis that all slope coefficients are jointly equal to zero. The data frequency is quarterly. The number of bootstrap sample is 5000.

	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup	Two-Asset	Three-Asset with Lockup	Three-Asset No Lockup
Hedge Fund Proxy:		**HFRIFoF Composite Index**			**HFRI Composite Index**	
Mean excess returns	21.8%	41.0%	60.5%	21.8%	58.6%	82.9%
Std. excess returns	20.9%	20.1%	24.4%	20.9%	24.0%	28.6%
Sharpe ratio	1.084	1.998 (0.000)	2.412 (0.002)	1.084	2.384 (0.000)	2.820 (0.005)
Unconditional vs. Conditional		(0.000)	(0.000)		(0.000)	(0.000)
Wald test of slope coefficients	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Conservative**			**HFRI Equity Hedge**	
Mean excess returns	21.8%	40.1%	57.9%	21.8%	47.6%	68.5%
Std. excess returns	20.9%	19.9%	23.8%	20.9%	21.7%	26.0%
Sharpe ratio	1.084	1.977 (0.000)	2.362 (0.004)	1.084	2.155 (0.000)	2.574 (0.003)
Unconditional vs. Conditional		(0.000)	(0.000)		(0.000)	(0.000)
Wald test of slope coefficients	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Diversified**			**HFRI Event-Driven**	
Mean excess returns	21.8%	39.4%	58.4%	21.8%	61.0%	88.0%
Std. excess returns	20.9%	19.7%	23.9%	20.9%	24.5%	29.5%
Sharpe ratio	1.084	1.956 (0.000)	2.370 (0.002)	1.084	2.437 (0.000)	2.908 (0.003)
Unconditional vs. Conditional		(0.000)	(0.000)		(0.000)	(0.000)
Wald test of slope coefficients	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Market Defensive**			**HFRI Macro**	
Mean excess returns	21.8%	41.8%	60.5%	21.8%	39.6%	56.0%
Std. excess returns	20.9%	20.3%	24.4%	20.9%	19.7%	23.4%
Sharpe ratio	1.084	2.019 (0.000)	2.415 (0.004)	1.084	1.966 (0.000)	2.325 (0.007)
Unconditional vs. Conditional		(0.000)	(0.000)		(0.000)	(0.000)
Wald test of slope coefficients	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hedge Fund Proxy:		**HFRIFoF Strategic**			**HFRI Relative Value**	
Mean excess returns	21.8%	39.4%	58.4%	21.8%	70.7%	107%
Std. excess returns	20.9%	19.7%	23.9%	20.9%	26.4%	32.5%
Sharpe ratio	1.084	1.959 (0.000)	2.372 (0.002)	1.084	2.620 (0.000)	3.196 (0.001)
Unconditional vs. Conditional		(0.000)	(0.000)		(0.000)	(0.000)
Wald test of slope coefficients	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

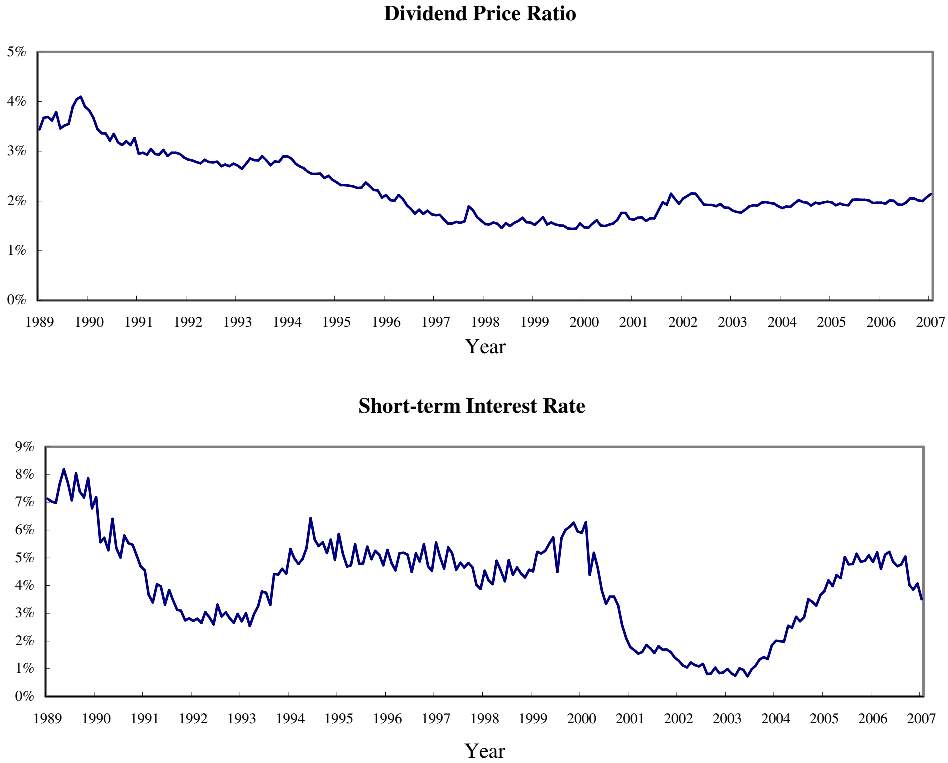

Figure 1. Evolution of State Variables. This figure displays the time series of two state variables: the market dividend price ratio and the short-term interest rate.

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