INVESTING IN GOVERNMENT BOND FUNDS:

DOES IT ADD ECONOMIC VALUE?

Abstract

We characterize the optimal portfolio decision of an investor who maximizes the conditional expected utility of the portfolio's return, given an investment opportunity set comprising a U.S. sovereign bond mutual fund and its benchmark. We estimate the optimal portfolio weight allocated to the U.S. government bond fund that depends on the realization of state variables, which are related to the government bond return distribution and the investor's conditional expected utility. Our results show that on average the investor should especially overweight the U.S. government bond funds during recession periods when the "level" factor of interest and the outputgap are low, and the "curvature" factor of the U.S. yield curve, the investor sentiment and the VIX are high, which are related to high U.S. bond risk premia. Important differences in optimal portfolio performance measures across bond fund managers also have a great impact on the investor's welfare. We show evidence of a positive relationship between the optimal portfolio performance measures and the average optimal weight allocated to the U.S. government bond funds.

Keywords: portfolio choice, U.S. government bond fund, state variables, recession.

JEL Classification: D8, E32, E43, G11, G12, G23.

1. Introduction

The increasing relevance of bond mutual funds to many investors' portfolios and the growth in the number of fixed-income funds and assets under management (Fulkerson et al. 2013) have motivated the growing academic research devoted to studying the bond fund performance using different risk-adjusted performance measures. Blake et al. (1993) and Elton et al. (1995) study the U.S.[1] bond mutual fund performance using funds' risk-adjusted returns. They find that bond funds underperform the return predicted by the relative pricing models by the amount of the expenses, indicating that pre-expenses the funds performed about on par with the relevant indexes. Ferson et al. (2006) evaluate the performance of U.S. government mutual funds during the period 1986–2000 using stochastic discount factors from continuous-time term structure models that incorporate time-varying expected returns. They conclude that fund returns vary more across the term structure states than across the fund groups formed on the basis of size, age, expenses and other common characteristics. After risk adjustment, the U.S. government bond funds deliver a negative conditional alpha after costs that is largely driven by funds' expenses, implying that before costs the performance is neutral. Chen et al. (2010) evaluate the ability of bond funds to "market time" nine common factors related to the bond markets, controlling for the non-timing-related non-linearity.

[1] Abbreviations: BENCHMARK: the style-matched benchmark return lagged one month; bp: basis points; CBOE: Chicago Board Options Exchange; $CP^{\perp}$: the Cochrane and Piazzesi factor (2005) orthogonalized to the level, slope and curvature factors; CRRA: constant relative risk aversion; CRSP: Center for Research in Securities Prices; GAP: output gap; GMM: generalized method of moments; IPO: initial public offering; NBER: National Bureau of Economic Research; NYSE: New York Stock Exchange; S&P 500: Standard and Poor's 500 Index; SENT: Baker and Wurgler's (2006) investor sentiment index; U.S.: United States; USD: United States dollars; USDMTBF: USD medium-term bond funds; USDSTBF: USD short-term bond funds; VIX: volatility index.

They find that by adjusting for non-linearity, the performance of many bond funds is negative on an after-cost basis but positive on a before-cost basis.

The aim of this paper is twofold. First, we characterize the optimal portfolio decision of an investor who maximizes the conditional expected utility of the portfolio's return, given an investment opportunity set comprising a U.S. government bond fund and its benchmark. Following Brandt et al. (2009), we make the optimal portfolio weight allocated to the U.S. government bond fund depend on the realization of state variables that are expected to be related to the bond return distribution and the investor's conditional expected utility. By doing so, we are also able to characterize the bond market scenarios in which a bond fund manager is expected to outperform the passive benchmark, depending on the realization of the state variables. Our approach also allows us to uncover the possible time-varying ability of bond fund managers depending on the state of the nature.

Second, we evaluate the economic value of considering the U.S. government bond funds in the investor's optimal portfolios vs. the passive strategy that only invests in the corresponding benchmark. Accordingly, we compute the performance of optimal portfolios using the annualized mean optimized portfolio excess return on the style-matched benchmark and the difference in certainty equivalent returns between the optimal portfolio and the passive strategy. The optimized portfolio performance measures, which are expected to be positive, will indicate whether the consideration of active management adds significant value to the investor or not. We also explore the possible dependence of the optimized portfolios' performance measures on the business cycle. Finally, we analyse the average optimal U.S. government bond fund weight implied by the strategies examined here. Smart (poor) government bond fund managers are expected to induce the investor to allocate on average a fraction of his/her wealth in the U.S. government bond fund closer to one (zero), providing a large (small) excess return and certainty equivalent over the benchmark. We also explore whether the average optimal U.S. government bond fund weight increases especially during recession periods, when the investor's marginal utility is low, and therefore constitutes high-valued states of the nature by the investor.

The choice of the state variables that characterize the investor information set and determine the optimal wealth allocated to the U.S. government bond fund and its benchmark can be motivated by the bond return predictability literature (see Section 2.4). Following this literature, we group the state variables that characterize the investor information set into state variables related to the yield curve, the macroeconomic environment and the investor sentiment. The principal component analysis applied to the yield curves (Litterman and Scheinkman 1991) recognizes that the zero yields of different maturities are likely to be correlated with a small number of latent factors, usually associated with the level of interest rates and the steepness and convexity of the yield curve. Thus, market timing arises as the crucial element to screen the good government bond fund managers who rebalance the portfolio among different maturity government bonds and cash, through the adjustment of the portfolio duration to time changes in interest rates. Boney et al. (2009) analyse the ability of high-quality corporate bond fund managers to shift their exposure to bond and cash and across bonds with different maturities in different bond market conditions. They use the fund's past return series and the quadratic programming technique of Sharpe (1992) to infer the investment policy of the fund through the estimation period and find that bond fund managers show poor timing ability in the two dimensions considered (cash vs bonds, and bonds with different maturities).

For the period 1994 to 2010, we analyse the U.S. government bond funds, which are sorted into three categories: "USD short-term bond funds", "USD intermediate-term bond funds" and "USD long-term bond funds" (USDSTBF, USDMTBF and USDLTBF hereafter). We find evidence that theoptimal portfolio weight allocated to the U.S. government bond funds is on average negatively related to the "level" factor of interest rates and the outputgap and positively related to the "slope" and "curvature" factors of the U.S. zero yield curve and to the orthogonalized Cochrane and Piazzesi(2005) bond risk premia estimate; it is also positively related to the Baker and Wurgler (2006) investor sentiment index and the VIX. The annualized average optimal portfolio excess return and equivalent certainty on the benchmark is larger than 49 and 45 basis points, respectively, considering all the short, intermediate and long-term U.S. government bond funds. Interestingly, it is especially during recession periods that the optimal portfolios deliver on average a higher excess return and equivalent certainty on the benchmark, above 130 basis points, corresponding to a higher average optimal portfolio weight allocated to the U.S. government bond funds. In general, U.S. government bond fund managers seem to pay special attention to their performance during recessions, when investors particularly value good bond fund performance, giving empirical support to Glode's (2011) theoretical model.

The general pattern described above is also observed when we analyse the quartiles of the U.S. government bond funds ranked by the optimal equivalent certainty achieved, with the exception of long-term bond funds that constitute a short sample in our study. The important differences in the optimized portfolio performance measures across quartiles in the whole sample are also observed during the recession periods, but with a lesser degree of significance. Thus, the U.S. government bond funds classified in Q1, which deliver higher optimal performance in the overall sample, also perform better during recessions, in which almost all the U.S. government bond funds achieve their best performance across the sample, and provide significant value to the investors. The positive relationship between the optimal portfolio performance and the average optimal portfolio weight allocated to the U.S. government bond funds is preserved across quartiles.

The rest of the paper is structured as follows: Section 2 provides the theoretical background; Section 3 describes the data used in the analysis; Section 4 presents our empirical findings; and Section 5 concludes.

2. Theoretical background

This section develops the theoretical approach of the paper. Section 2.1 formulates the investor optimization problem. We characterize the optimal portfolio weight allocated in each period to the U.S. government bond fund and the benchmark following Brandt et al. (2009). The optimal portfolio weight depends on the realization of state variables that are related to the government bond return distribution. We present the main elements used in this paper to evaluate the optimal portfolio strategy: the optimal investor portfolio excess return and certainty equivalent over the benchmark. We also consider the average optimal portfolio weight allocated to the U.S. bond fund, which is expected to be positively related to the optimal portfolio performance measures. Section 2.2 presents the estimation of the model parameters using the generalized method of moments (GMM), which reveals the relationship between the optimal government bond fund weight and the state variables. Section 2.3 shows the construction of the style-matched benchmark return, implementing the Sharpe (1992) approach, used to evaluate the U.S. government bond fund performance. Finally, Section 2.4 describes the choice of the state variables following the literature on bond return predictability.

2.1. The investor's optimal allocation problem

Let us consider the U.S. investor problem, which consists of determining the optimal portfolio allocation at time t, given an investment opportunity set comprising a U.S. government bond fund, for which the usual risk-adjusted performance measures can be different from zero, and its style-matched benchmark. The investment opportunity set is defined by the vector $P_t = \left(F_t \ , B_t\right)$ with F_t the price at time t of the U.S. government bond fund net of fees and B_t the price at time *t* of the benchmark; the devised investment portfolio is $W_t = \alpha_{F,t} F_t + \left(1-\alpha_{F,t}\right) B_t$, with W_t denoting wealth at time *t* and $\alpha_{F,t}$ and $\left(1-\alpha_{F,t}\right)$ the share of wealth to be allocated to the U.S. government bond fund and the benchmark, respectively. After one month, the return on this portfolio is $rw_{t+1} = \alpha_{F,t}\, r_{F,t+1} + \left(1-\alpha_{F,t}\right) r_{B,t+1}$, with $r_{F,t+1}$ and $r_{B,t+1}$ denoting the U.S. government bond fund return and benchmark return at time *t+1*, respectively. From this expression, it is straightforward to see that the return on this portfolio can be expressed as:

$$rw_{t+1} = r_{B,t+1} + \alpha_{F,t}\left(r_{F,t+1} - r_{B,t+1}\right). \tag{1}$$

The evolution of the investor wealth will depend crucially on the share of wealth allocated to the U.S. government bond fund and its excess return on its style-matched benchmark.

We follow Brandt et al. (2009) and model the optimal U.S. government bond fund weight, $\alpha_{F,t}$, directly as a function of several state variables, Z_t, which might be related to the U.S. government bond return distribution, that is,

$$\alpha_{F,t} = \alpha\left(Z_t;\beta\right) = Z_t^{'}\beta \,, \tag{2}$$

with beta a vector of coefficients to be optimally selected. The solution to the investor's problem is the time-invariant mapping from the state vector Z_t to the portfolio weight, $\alpha_{F,t}$. The main advantage of focusing directly on the optimal portfolio weights is that we avoid the estimation of the conditional asset return distributions.

The investor's optimal allocation problem is to maximize his or her expected utility conditional on the sigma-algebra determined by the available information set. This problem is mathematically stated as:

$$\underset{\beta}{Max}\, E_t\left[U(rw_{t+1};\beta)\middle|\Omega_t\right], \tag{3}$$

with $U(rw_{t+1};\beta)$ denoting the investor's utility and Ω_t the corresponding sigma-algebra. The optimization problem implicitly takes into account the relation between the state variables and the expected returns, variances and higher-order moments of returns, to the extent that they affect the distribution of the optimized portfolio returns, which are connected to the investor's expected utility (Brandt et al. 2009). Therefore, the investor optimization problem is able to accommodate non-normal returns, allowing us to avoid mean-variance benchmarks, and asset return predictability.

The first-order conditions of this maximization problem are:

$$E_t\left[U^{'}\left(rw_{t+1};\beta\right)\left(r_{F,t+1} - r_{B,t+1}\right)\middle|\Omega_t\right]=0, \tag{4}$$

with $U^{'}\left(rw_{t+1};\beta\right)$ denoting the investor's marginal utility. Note that the factor Z_t inside the conditional expectation operator vanishes by assuming that Z_t is contained in the sigma-algebra Ω_t. Further, we assume that the information contained in Ω_t is completely reflected by the vector Z_t, that is, $\Omega_t = Z_t$. In order for this condition to hold, we need to assume that no lag of Z_t or any other variable different from the state variables adds informational content to Ω_t beyond that provided by the information set z_t. In this case, the above condition implies that:

$$E\left[U^{'}\left(rw_{t+1};\beta\right)\left(r_{F,t+1}-r_{B,t+1}\right)\ Z_t\ \right]=0. \tag{5}$$

Equation (4) is similar to the equilibrium condition obtained in the analysis of Ferson and Lin (2011). They derive the Euler equation, which must be satisfied if the client has optimized the portfolio and consumption choice in an intertemporal setting. If the client has access to a fund with a non-zero stochastic discount alpha (SDF), the investor adjusts the portfolio composition, purchasing more (less) of the fund if the alpha is positive (negative), until the SDF alpha portfolio is zero. From their SDF alpha definition, which is tied to the client's marginal utility function, it is easy to establish the relationship with our equation (4) defined in a two-period model. In our framework, the investor will invest in the government bond fund according to the optimal investment portfolio rule (2), which is also related to the investor's marginal utility, until the expected risk-adjusted return of the investment strategy that goes long in the U.S. government bond fund and short in the passive style-matched benchmark is zero.

The investor information set implicitly assumes that the U.S. government bond fund managers might consider the state variables that explain the U.S. government bond return distribution to determine the fund's resource allocation to the different maturity classes. Intuitively, the U.S. bond fund manager could modify the exposure of the fund to the different maturity classes with respect to the style-matched benchmark, depending on the signal provided by the state variables about the future relative performance of the maturity classes. For example, if the U.S. bond fund manager anticipates future decreasing (increasing) interest rates, he/she is likely to increase (decrease) the duration of the fund with respect to the benchmark.

We use the following metrics to measure the economic performance of the optimized portfolios: 1) the annualized mean optimized portfolio excess return on the style-matched benchmark and 2) the difference in certainty equivalent returns (CERs), defined as the annualized difference between the CER calculated from the utility of the optimized portfolio that invests in U.S. government bond funds and the style-matched benchmark and the CER corresponding to the utility of the passive strategy that invests in the style-matched benchmark. We also explore the relationship between the optimized portfolios' performance measures and the optimal $\alpha_{F,t}$.

We can infer whether the U.S. government bond fund manager has been exploiting the available information adequately through optimized (2). If the U.S. government bond fund manager is successful and incorporates in a timely manner the information embedded in the state variables about the future U.S. bond return distribution, the vector β should be significantly related to the state variables, and $\alpha_{F,t}$ will take higher values and be closer to one in the considered period. The smart bond fund manager is also expected to deliver a high excess return and certainty equivalent on the style-matched benchmark. Conversely, if the U.S. government bond fund manager is unsuccessful, the optimal $\alpha_{F,t}$ will take lower values and be closer to 0, and is expected to deliver an almost insignificant excess return and certainty equivalent on the style-matched benchmark. Our approach can also potentially accommodate the case of time-varying government bond funds' market-timing ability across the states of the economy.

2.2. Estimation of the model parameters

Let $h\left(rw_{t+1}, Z_t; \beta\right) = U^{'}\left(rw_{t+1}; \beta\right)\left(r_{F,t+1} - r_{B,t+1}\right) Z_t$. The sample analogue of expression (5) is:

$$\left(1/T\right)\sum_{t=0}^{T-1} h\left(rw_{t+1}, Z_t; \beta\right) = 0. \tag{6}$$

Under standard regularity conditions for the utility function, the estimation problem of the relevant parameters can be interpreted as a method of moments estimator as developed by Hansen (1982). The idea behind the generalized method of moments (GMM) is to choose β so as to make the sample moment $\left(1/T\right)\sum_{t=0}^{T-1} h\left(rw_{t+1}, Z_t; \beta\right)$ as close to zero as possible. This is achieved by minimizing the scalar:

$$\left[\left(1/T\right)\sum_{t=0}^{T-1} h\left(rw_{t+1}, Z_t; \beta\right)\right]^{'} V_T^{-1}\left[\left(1/T\right)\sum_{t=0}^{T-1} h\left(rw_{t+1}, Z_t; \beta\right)\right], \tag{7}$$

where V_T admits different choices of the covariance matrix. In the first stage, V_T is the identity matrix, and in the second stage, to gain efficiency, this matrix is replaced by a consistent estimator of the asymptotic covariance matrix, V, of the random vector $h\left(rw_{t+1}, Z_t; \overline{\beta}\right)$. To find a suitable expression for this estimator, we exploit condition (4), which implies that $h\left(rw_{t+1}, Z_t; \beta\right)$ is a martingale difference sequence with respect to Ω_t . Using this fact, V_T can be expressed as:

$$V_T = \left(1/T\right)\sum_{t=0}^{T-1} h\left(rw_{t+1}, Z_t; \overline{\beta}\right) h^{'}\left(rw_{t+1}, Z_t; \overline{\beta}\right), \tag{8}$$

with $\overline{\beta}$ a consistent estimator of β obtained from minimizing (7) in the first stage. An asymptotic inference on these coefficients is obtained using the standard results of the GMM estimation. Thus, the asymptotic covariance matrix of the GMM estimator vector for β is:

$$\Gamma_T = (1/T)\left[G_T^{'} V_T^{-1} G_T\right]^{-1}, \tag{9}$$

where

$$G_T = (1/T)\sum_{t=0}^{T-1} \frac{\partial h\left(rw_{t+1}, Z_t; \overline{\beta}\right)}{\partial \beta}. \tag{10}$$

In order to make these theoretical results operational, we assume that the investor's utility function is isoelastic or constant relative risk averse (CRRA) and takes the following form:

$$U\left(rw_{t+1}\right) = \frac{\left(1 + rw_{t+1}\right)^{1-\gamma}}{1-\gamma} \tag{11}$$

with γ denoting the investor's constant relative risk aversion (CRRA) coefficient. If γ =1, the utility function is $U(rw_{t+1}) = \log\ (1 + rw_{t+1})$, where γ is the investor's relative risk aversion coefficient. Under CRRA utility, the CER is computed as:

$$CER = \left((1-\gamma)T^{-1}\sum_{t=1}^{T} U\left(1 + rp_{t+1}\right)\right)^{1/(1-\gamma)} - 1. \tag{12}$$

2.3. Fund benchmarks

We construct a style-matched benchmark return using the Sharpe (1992) approach. We assume that the monthly return of each U.S. government bond fund, denoted by R_p, can be represented by asset class returns, denoted by R_i. Taking into account our focus on funds that invest in U.S. government bonds, we consider the following 6 asset class returns, R_i: the 3-month Treasury bill return and the U.S. government bond indices returns provided by the Bank of America Merrill Lynch, which track the evolution of different maturity classes of 1–3 years, 3–5 years, 5–7 years, 7–15 years and over 15 years. This gives us 6 indices with different maturities.

The average exposure of each U.S. government bond fund to each asset class, ω_i , during the estimation window can be estimated by the following quadratic programme:

$$\begin{aligned} & Min_{\{\omega_i\}} Var\left[R_p - \sum_i \omega_i R_i \right] \\ & \sum_i \omega_i = 1, \omega_i \geq 0 \, \forall i, \end{aligned} \tag{13}$$

where Var[.] denotes the variance.

The problem minimizes the “tracking error” of the return of each U.S. government bond fund, R_p, and the style-matched benchmark portfolio, $\sum_i \omega_i R_i$. The portfolio weights are required to sum to 1.0 and must be non-negative, ruling out short positions, and constitute the average weights for the indexing strategy that best explains the fund return over the estimation period.

We solve the problem for the estimation window January 1994 to September 2010, considering all the U.S. government bond funds from a database provided by Thomson Reuters (see Section 3).

2.4. The investor information set and state variables

We hypothesize that the investor's optimal asset allocation to the U.S. government bond fund depends on his/her information set, which is characterized by the state variables, Z_t, which are related to the U.S. government bond return distribution at *t+1*. This approach is compatible with the failure of the expectations theory of the term structure of interest rates, which states that the long yields are the average of future expected short yields, implying that the expected excess returns on bonds should not be forecastable. Despite prominent efforts to provide empirical support for this theory, its failure is largely documented in many studies. Fama and Bliss (1987) and Campbell and Shiller (1991), using the forward-spot rate differential and the slope of the yield curve, report evidence on the existence of time-varying risk premia in U.S. bond markets, implying that excess returns have a predictable component. Litterman and Scheinkman (1991) show that three factors explain almost all the return variability across the whole maturity spectrum: the "level" factor, the "slope" factor and the "curvature" factor. Cochrane and Piazzesi (2005) introduce a single-return factor, which is a tent-shaped linear combination of five forward rates, and succeed in predicting the one-year excess return of the n-year bond (n=2…5) with an R^2 higher than 35% in most cases. This single-return factor appears to be countercyclical and cannot be entirely explained by the level, slope and curvature of the yield curve.

The recent literature has documented the existence of factors that link the countercyclical behaviour of bond risk premia with expected excess returns on U.S. government bonds at the highest (lowest) levels during recession (expansion) periods to variables not directly extracted from the yield curve. Cooper and Priestly (2009) find that the output gap has predictive power for excess bond returns beyond that of the term structure. Ludvigson and Ng (2009) find that "real" and "inflation" factors have important forecasting power for future excess returns on U.S. government bonds above and beyond the predictive power contained in forward rates and yield spreads.

It is also plausible to assume that bond prices are affected by subjective investors' beliefs on the state of such a real economy and its effects on the bond prices. Baker and Wurgler (2012) analyse the relationship between the investor sentiment and the comovement between government bonds and bond-like stocks, characterized as long mature, low volatility, profitable, from dividend-paying firms and having neither high growth nor distress. These authors find that when the investor sentiment index is high and subsequent returns on bond-like stocks are expected to outperform speculative stocks, bond returns are also expected to be positive. Interestingly, the investor sentiment is a measure related to the equity market (see Baker and Wurgler 2006), defined as the first principal component of the correlation matrix of six variables: the closed-end fund discount, the NYSE share turnover, the number of IPOs and their average first-day returns, the share of equity issues in the total equity and debt issues and the dividend premium. Laborda and Olmo (2014) also document empirically a positive relationship between the investor sentiment index and the expected excess bond returns that is above and beyond the information contained in the term structure of bonds and macroeconomic factors, especially when the investor sentiment is high. Another sentiment variable that could reflect periods of flight to quality in the financial markets, which affect the performance of safe and liquid assets, like the U.S. government bond, is the VIX index. This "investor fear gauge" is a forward-looking market indicator describing uncertainty in financial markets from the implied volatility underlying options on the S&P 500 index.

Following the discussion above, we consider the following state variables to characterize the investor information set: a) state variables related to the yield curve: the "level" factor, the "slope" factor and the curvature "factor" extracted from the U.S. zero-coupon yield curve. We also consider an additional variable linked to the yield curve: the Cochrane and Piazzesifactor (2005) orthogonalized to the level, slope and curvature factors ($CP^{\perp}$); b) state variables related to macro factors: we consider the output gap (GAP) as a state variable closely related to pure macroeconomic factors; c) state variables related to the investor sentiment: we include the Baker and Wurgler (2006) investor sentiment index (SENT), the VIX and the style-matched benchmark return lagged one month (BENCHMARK).

The optimal U.S. government bond fund weight specification is given by (13):

$$\alpha_{F,t} = \alpha(Z_t;\beta) = \beta_0 + \beta_L\ L_t + \beta_S\ S_t + \beta_C\ C_t + \beta_{CP^{\perp}}\ CP^{\perp}{}_t + \beta_{VIX}\ VIX_t + \beta_{GAP}\ GAP_t + \beta_{SENT}\ SENT_t + \beta_{BENCHMARK}\ BENCHMARK_t. \tag{14}$$

3. Data

We carry out the U.S. government bond fund performance analysis for the period January 1994 to September 2010. We use three different data sets in our study: bond funds, style-based benchmark returns and primitive assets, and state variables.

3.1. Bond funds

We focus on U.S. government bond funds that invest mainly in U.S. government bonds with different maturities. All the fund data were provided by ThomsonReuters. We select the U.S. government bond funds sorted into three categories: "USD short-term bond funds", "USD medium-term bond funds" and "USD long-term bond funds", for the period January 1994 to September 2010. From this universe, we require mutual funds to have existed before January 2004,to make sure that the considered funds have been exposed at least to a complete interest rate cycle, allowing us to interpret the results depending on different bond market scenarios and to enhance the efficiency of our estimates.

Thomson Reuters provides information for each share class fund separately. We aggregate the different share classes for a given fund into one observation using the method implemented by Renneboog et al. (2011). This method consists of two steps: (i) first, the TNAs of the different share classes of a given fund are aggregated and (ii) second, for fund returns, the weighted average of this variable is taken using one-month-lagged TNAs of the individual share classes as weights. The resulting sample consists of 24 USDSTBF, 69 USDMTBF and 11 USDLTBF. For each of the funds, the information collected is the monthly return net of fees and other expenses. Table A.1 in the Appendix lists the USDSTBF and provides some descriptive statistics. The mean monthly return ranges from 0.45% forthe *Sit U.S. Government Securities Fund*to 0.29% achieved bythe *Federated Government UltrashortDuratn Fund*. The maximum monthly return is obtained by the *C/Funds Group, Inc: C/Government Fund* (2.94%) and the minimum monthly return is achieved by the*Oppenheimer Limited-Term Government Fund* (-5.6%). For eight funds, the return distribution is skewed to the right and for the rest (sixteen funds), the return distribution is skewed to the left. Applying the Jarque–Bera test, we can reject the hypothesis of normal distribution for eighteen of the twenty-four USDSTBF. Besides, significant first-order autocorrelation is detected for twenty-two mutual funds.

Table A.2 in the Appendix shows the USDMTBF included in our sample. The mean monthly return ranges from 0.63% for the *ACM Government Opportunity Fund* to 0.28% for the *California U.S. Government Bond Fund*. The*Putnam U.S. Government Income Trust* yields the maximum monthly return andthe *ACM Government Opportunity Fund* obtains the minimum monthly return in the sample (6.44% and

6.84%, respectively). The monthly return distribution is skewed to the right for fourteen funds and to the left for fifty-five funds. We cannot reject the hypothesis of normal distribution only for ten funds. Additionally, significant first-order autocorrelation is detected for forty-two mutual funds.

Finally, Table A.3 in the Appendix provides information about the USDLTBF. The mean monthly return ranges from 0.70% for the *PIMCO Long-Term U.S. Government Fund*to 0.14% for the *Rydex Government Long Bond 1.2x Strategy Fund*. The *Rydex Government Long Bond 1.2x Strategy Fund*reaches the maximum and the minimum monthly returns (18.39% and -25.38%, respectively). The monthly return distribution is skewed to the left for ten mutual funds and to the right for one mutual fund. With regard to the normality test, the hypothesis of normal distribution is rejected for all the funds. Besides, significant first-order autocorrelation is detected for two mutual funds.

3.2. Style-based benchmark returns and primitive assets

We solve the problem (13) for each U.S. government bond fund, obtaining its style-based benchmark. The style-based benchmark is used to create the optimal investor strategy and is the reference point for evaluating the optimal portfolio performance measures and the market-timing skills of bond fund managers. Taking into account that we are analysing funds that invest in U.S. government bonds, we consider the following six indexes to create the style-matched benchmark: the three-month Treasury bill return, the *Bank of America Merrill Lynch 1–3 U.S. Year Treasury Index*, the *Bank of America Merrill Lynch 3–5 U.S. Year Treasury Index*, the *Bank of America Merrill Lynch 5–7 U.S. Year Treasury Index*, the *Bank of America Merrill Lynch 7–15 U.S. Year Treasury Index*andthe *Bank of America Merrill Lynch >15 U.S.- Year Treasury Index*.

The Bank of America Merrill Lynch U.S. Year Treasury Indexes track the performance of the U.S. Government sovereign debt with different maturities. Table 1 reports the main descriptive statistics for the monthly returns achieved by these indexes. As might be expected, the mean monthly return is positively related to the index maturity: it ranges from 0.39% for the 1–3 year index to 0.63% for the >15 year index. The maximum and minimum monthly returns are provided by the >15 year index with 13.12% and -11.87%. All the indexes except the *Bank of America Merrill Lynch 1–3 U.S. Year Treasury Index* are slightly skewed to the left. Finally, we reject the hypothesis of normal distribution for the two indexes with a longer maturity, that is, the *Bank of America Merrill Lynch 7–15 U.S. Year Treasury Index* and the *Bank of America Merrill Lynch >15 U.S. Year Treasury Index.*

The solution to the problem (12) delivers sensible Sharpe-style index weights for the USDSTBF, USDMTBF and USDLTBF, classified as U.S. government bond funds that invest in short maturity assets, intermediate maturity assets and long-term maturity assets, respectively. The average USDSTBF weight vectors (47%, 35%, 13%, 3%, 2%, 0%) have most of their weight in bonds with less than 3 years; the average USDMTBF weight vector (29%, 25%, 18%, 14%, 11%, 3%) is also significantly exposed to the 3–5 year, 5–7 year and 7–15 year U.S. Year Treasury Indexes, providing an intermediate duration portfolio, and the average USDLTBF weight vector(7%, 9%, 13%, 17%, 22%, 32%) is more exposed to the long-term yield curve.

3.3. State variables

The investor information set contains eight state variables grouped into state variables related to the yield curve, state variables related to macro factors and state variables related to the investor sentiment:

a) State variables related to the yield curve. We extract the "level" factor, the "slope" factor and the "curvature" factor from the database of U.S. zero-coupon yields constructed by Gurkaynak et al. (2007), which contains maturities up to thirty years with a daily frequency in the period November 1985[2]–September 2010. These factors are obtained by applying principal component analysis to the U.S. zero-coupon yield curve using a monthly frequency. Table 2 shows that the first three components explain almost 100% of the variability of the zero-coupon yields. The first factor is the most important, for the entire set of zeros accounts for 96% of the total explained variance. We display the principal component loadings in Figure 1. The first principal component loads all the zeros similarly, and can be interpreted as a "level" factor. The second principal component corresponds to a "slope" factor. The third factor corresponds to a "curvature" factor showing a "bowing" of the yield curve. The rates at the short and the long move in one direction; the rates in the middle move in the other direction. Figures 2–4 display the "level" factor, the "slope" factor and the "curvature" factorin the period in which we evaluate the U.S. government bond fund performance. It is worth noting that the period is characterized by a gradual decrease in the level of interest rates.

We also consider an additional variable linked to the yield curve: the Cochrane and Piazzesi factor (2005) orthogonalized to the level, slope and curvature factors ($CP^{\perp}$).We use the Fama–Bliss dataset available from the Center for Research in Securities Prices (CRSP), which contains observations on one- to five-year zero-coupon U.S. Treasury bond prices for the period from August 1965 to September 2010. We construct data on excess bond returns, yields and forward rates, as described by Cochrane and Piazzesi (2005), and estimate the CP factor. Then, we run the regression of the CP factor (2005) on the "level" factor, the "slope" factor and the "curvature" factor, and we consider the

[2]The first date with yields available for all the maturities.

residual from this regression as the Cochrane and Piazzesi factor (2005) orthogonalized to the level, slope and curvature factors ($CP^{\perp}$). Consequently, we obtain an estimate of the U.S. bond risk premia unrelated to the three-factor model,[3] which is displayed in Figure 5.

b) State variables related to macro factors. We consider the output gap (GAP) as a state variable closely related to pure macroeconomic factors. We estimate the output gap following the Cooper and Priestly (2009) main measure of the output gap (see equation 1) using the industrial production index, obtained from the U.S. Federal Reserve website (http://www.federalreserve.gov/econresdata/statisticsdata.htm), as the variable representing economic activity. We consider the period August 1965 to September 2010. Figure 6 shows the outputgapin the period for which we evaluate the U.S. government bond fund performance.

c) State variables related to the investor sentiment. We include the Baker and Wurgler (2006) investor sentiment index (SENT) available on Jeffrey Wurgler's web page (http://pages.stern.nyu.edu/~jwurgler/), the VIX taken from the CBOE web page (http://www.cboe.com) and the benchmark return lagged one month (BENCHMARK). Figures 7 and 8 plot the investor sentiment index and the VIX in the period for which we evaluate the U.S. government bond fund performance.

Table 3 reports the summary statistics of the state variables in the period from January 1994 to September 2010.

4. Investors' optimal strategies

[3]The regression estimates are available on request from the authors.

In this section, we solve the U.S. investor problem, which consists of determining the optimal portfolio allocation at time t corresponding to an investment opportunity set characterized by a U.S. government bond fund and its benchmark. Initially, we solve the naïve unconditional portfolio choice problem, which considers a constant investor information set and the fraction of wealth allocated to each U.S. government bond fund available in the dataset. Finally, we report the results for the conditional portfolio choice problem, which considers the fraction of wealth allocated to each U.S. government bond fund, depending on the realization of the state variables. We assume that the investor's utility function is isoelastic with a constant relative risk aversion equal to 10.We use a two-step estimator and a weight matrix that allows for heteroskedasticity and autocorrelation up to four lags using the Bartlett kernel given the significant first-order autocorrelation of the fund returns reported in Table A.1.

4.1 Unconditional portfolio choice

We begin our empirical work by characterizing the unconditional portfolio choice of an investor who invests a constant fraction of his/her wealth in the U.S. government bond fund and the passive benchmark and does not consider any state variable related to the future government bond return distribution to market time the bond market. We do not impose any restriction on the optimal solution. This simple investor's asset allocation rule allows us to gain a straightforward understanding of the overall U.S. bond fund managers' performance. Table 4 reports the summary statistics of the unrestricted optimal weight for the USDSTBF, USDMTBF and USDLTBF categories. In all the cases, the average α_F is negative, which implies that on average the investor should have gone long in the passive benchmarks and short in the fund. The average of the USDMTBF unrestricted optimal weight is slightly more negative than those of the

USDSTBF and the USDLTBF. In the individual fund-level analysis, the percentage of USDSTBF with a positive (negative) unrestricted optimal weight is about 46% (54%). The percentage of USDMTBF with a positive (negative) unrestricted optimal weight is about 30% (70%). The percentage of USDLTBF with a positive (negative) unrestricted optimal weight is about 27% (73%). These results give indirect evidence of the negative unconditional performance of the overall U.S. government bond fund performance on an after-cost basis. However, the investor would be better off if he/she could screen good managers from bad managers depending on the state of the economy.

4.2 Conditional portfolio choice

Turning now to the conditional portfolio choice problem, we solve the more realistic problem of an investor embedded with an information set that includes all the state variables considered in section 2.4; we also impose the short-sale constraint $0<\alpha_{F,t}<1$, to prohibit unrealistic leveraging and short selling.

We solve the investor optimization problem (3), which provides us with the relationship between the optimal portfolio weight allocated to each U.S. government bond fund and the state variables. We also compute the optimized portfolio performance measures, which allow us to investigate the economic value of considering the U.S. government bond fund as an asset class vs the investor who only pursues the passive strategy.

Tables 5, 6 and 7 show the relationship between the optimal weight allocated to the USDSTBF, USDMTBF and USDLTBF and the state variables. The first and second rows display the mean and median coefficients for each state variable across funds. The next rows show the percentage of funds with positive or negative estimated coefficients for each state variable and their degree of significance. The estimates are more precise than in the unconditional portfolio choice setting due to the increasing investor information set considered.

Tables 5, 6 and 7 show that the optimal portfolio weight allocated to the USDSTBF, USDMTBF or USDLTBF is on average negatively related to the “level” factor of interest rates and the outputgap and positively related to the “slope” and “curvature” factors of the U.S. zero yield curve and to the orthogonalized Cochrane and Piazzesi(2005) bond risk premia estimate; it is also positively related to the Baker and Wurgler (2006) investor sentiment index and the VIX. The one-month-lagged bond fund excess return on the benchmark is negatively related to the USDSTBF optimal portfolio weight and positively related to the USDMTBF and USDLTBF optimal portfolio weight.

The relationship between the optimal USDSTBF, USDMTBFand USDLTBF portfolio allocation and the state variables shows on average that the investor should overweight the U.S. government bond funds when the “level” factor of interest and the outputgap are low, characterizing a weakening economic cycle, and the “curvature” factor of the U.S. yield curve, the Baker and Wurgler (2006) investor sentiment and the VIX are high, which are related to high U.S. bond risk premia. Our results are in the spirit of Ferson et al. (2006) and outline the importance of the term structure states to characterize the variability of the U.S. government bond fund performance. However, we also emphasize the role played by macroeconomic variables and investor sentiment variables to screen better the good U.S. government bond fund managers from the poor U.S. government fund managers.

At the individual fund level, the percentage of USDSTBF, USDMTBF or USDLTBF with a negative relationship between the optimal fund weight and the “level” factor of interest rates and the outputgap is larger than 79% and 90%, respectively, with the largest percentage of funds with significant parameters across the state variables for the outputgap (above 54%). The percentage of USDSTBF, USDMTBF or USDLTBF with a positive relationship between the optimal fund weight and the “curvature” factor of the U.S. zero yield curve and the orthogonalized Cochrane and Piazzesi (2005) bond risk premia estimate is larger than 94% and 75%, respectively, with an increasing percentage of funds with significant parameters across the time horizon investment strategy for each state variable, with remarkable values for the “curvature” factor above 50%.

The percentage of USDSTBF, USDMTBF or USDLTBF with a positive relationship between the optimal fund weight and the Baker and Wurgler (2006) investor sentiment is larger than 54%, with a decreasing percentageof funds with significant parameters across the time horizon investment strategy. Additionally, the percentage of USDSTBF, USDMTBF or USDLTBF with a positive relationship between the optimal fund weight and the VIX is larger than 65%, with a percentageof funds with significant parameters lower than 35%. Finally, the percentageof USDSTBF, USDMTBF or USDLTBF with significant parameters linked to the slope factor and the one-month-lagged bond fund excess return on the benchmark is relatively low.

Table 8 reports the mean of the USDSTBF, USDMTBF and USDLTBF optimal portfolios’ excess return and equivalent certainty on the benchmark in annualized terms, as well as the statistics of their average optimal weights considering the whole sample and during U.S. recession periods.

As expected, the mean of the USDSTBF, USDMTBF and the USDLTBF optimal portfolios’ excess return and equivalent certainty on the benchmark in annualized terms are positive. Hence, the optimal convex combination of the government bond fund and the benchmark conditioned on the realization of the state variables delivers a higher performance than the benchmark. This empirical result is similar in spirit to the Dybvigand Ross (1985b) Theorem 5, which states that if a fund has a positive alpha related to the benchmark, then a convex combination of the fund and the benchmark will result in a higher Sharpe ratio than the benchmark.

The USDSTBF, USDMTBF and USDLTBF obtain an average optimal portfolio excess return on the benchmark larger than 49 basis points taking into consideration the whole sample. Interestingly, it is especially during recession periods that the optimal portfolios deliver on average a higher excess return on the benchmark, above 130 basis points. The average optimal portfolio excess equivalent certainty on the benchmark is above 45 basis points given the whole sample and exceeds 130 basis points during recession periods on average. Obviously these figures constitute the upper value of the transactions costs, not considered in this paper, which an investor could assume when buying/selling the passive benchmark.

On average, the optimization process seems to achieve adequate market timing between the U.S. government bond fund and the passive benchmark, and especially during the recession periods it is tilted on average towards the USDSTBF, USDMTBF and USDLTBF. The mean of the average optimal weight allocated to the funds is around 40%, implying that the mean of the average optimal weight allocated to the passive benchmark is 60% considering the whole sample. Thus, the optimal investor decision is tilted on average towards the passive benchmark. However, the mean of the average optimal weight allocated to the funds increases especially during recession periods, and hence it is conditioned on the economic state described by the state variables. The mean of the average optimal weight during recession periods is more relevant to the USDSTBF and USDMTBF than to the USDLTBF, reaching a mean of the average optimal weight close to 70%, 67% and 47%, respectively. The USDSTBF and USDMTBF especially invest in short-/medium-term government bonds, the yields of which might move more in accordance with the business cycle and the monetary policy than long-term government bonds that constitute the main asset class eligible for the USDLTBF.

Table 8 uncovers higher USDSTBF, USDMTBF and USDLTBF optimal portfolio performance values linked to the higher mean of the average optimal weight values during the bad states of the economy. In general, government bond funds' market-timing ability seems to be stronger during recession periods, when the investor's marginal utility of wealth is high. These results are in the spirit of Kowsowski (2011), who uses a regime-switching model to study fund performance in economic expansions and contractions and finds that growth/income and balanced income/good fund performance are usually concentrated in recessions. Our empirical findings can also give empirical support to the fact that investors might wish to invest in negative alpha funds if the fund manager can generate state-specific active returns in recession periods (Glode 2011). In these periods, investors are willing to pay insurance against bad states of nature. It is worthwhile noticing that our empirical approach is able to identify government bond funds that perform well not only during bad states of the economy but also during good states of the economy.

Tables 9–12 decomposes the above analysis by considering the quartiles of the means of the USDSTBF, USDMTBF and USDLTBF optimal portfolios' excess return and equivalent certainty on the benchmark in annualized terms, as well as the statistics of their average optimal weights given the whole sample and during U.S. recession periods. We rank all the U.S. government bond funds according to the optimal equivalent certainty reached by including each U.S. bond fund in the optimal portfolio.

These tables also show higher USDSTBF, USDMTBF and USDLTBF optimal portfolio performance values linked to a higher mean of the average optimal weight values in the overall sample. Optimal portfolios' excess return and equivalent certainty on the benchmark in annualized terms show a decreasing pattern (from almost 100 basis points in Q1 to around 20 basis points in Q4) that is associated with lower average optimal portfolio weights allocated to the U.S. bond funds (from around 55% in Q1 to below 30% in Q4), with the exception of USDLTBF, which comprise only 11 funds. These important differences across quartiles in the whole sample are also observed during the recession periods. U.S. government bond funds that deliver higher optimal performance in the overall sample also perform better during recessions, when almost all the U.S. government bond funds achieve their best performance across the sample.

5. Conclusion

We characterize the optimal portfolio decision of an investor who maximizes the conditional expected utility of the portfolio's return, given an investment opportunity set comprising a U.S. government bond fund and its benchmark. We make the optimal portfolio weight allocated to the U.S. government bond fund depend on the realization of state variables and evaluate the performance of optimal portfolios using the annualized mean optimized portfolio excess return on the style-matched benchmark and the difference in certainty equivalent returns between the optimal portfolio and the passive strategy. We also explore the possible dependence of the optimized portfolios' performance measures on the business cycle and analyse the average optimal U.S. bond fund weight implied by the strategies examined here.

In the period 1994 to 2010, we find evidence thattheoptimal portfolio weight allocated to the U.S. short-, intermediate- and long-term government bond funds is on average negatively related to the “level” factor of interest rates and the outputgapand positively related to the “slope” and “curvature” factors of the U.S. zero yield curve and to the orthogonalized Cochrane and Piazzesi(2005) bond risk premia estimate; it is also positively related to the Baker and Wurgler (2006) investor sentiment index and the VIX. The annualized average optimal portfolio excess return and equivalent certainty on the benchmark are larger than 49 and 45 basis points, respectively, for the whole sample, adding value to the investor. Interestingly, it is especially during recession periods that the optimal portfolios deliver on average a higher excess return and equivalent certainty on the benchmark, above 130 basis points, corresponding to a higher mean average optimal portfolio weight allocated to the U.S. government bond funds. This pattern is also observed when we analyse the U.S. government bond funds by quartiles, ranked by their optimal equivalent certainty achieved, with the exception of USDLTBF.

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APPENDIX

Table A.1: Descriptive statistics of USD Short-Term Government Bond funds

	Mean Return (%)	Median Return (%)	Max Return (%)	Min Return (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera	Obs.	r1	Mean TNA	Median TNA
American Century Short-Term Government Fund	0.35	0.33	1.72	-0.98	0.48	-0.022	3.358	1.089	201	0.224***	807.25	873.7
Asset Management Short US Government Fund	0.32	0.34	2.20	-2.08	0.61	-0.655	5.546	68.69***	201	0.325***	136.56	145.3
Atlas US Government & Mortgage Securities Fund	0.41	0.41	2.80	-3.27	0.85	-0.336	4.775	24.16***	161	0.243***	264.81	243.4
BB&T Short US Government Fund	0.35	0.33	2.61	-1.38	0.58	0.074	4.168	11.60***	201	0.239***	121.22	143.3
C/Funds Group, Inc: C/Government Fund	0.34	0.27	2.94	-1.65	0.68	0.740	5.346	46.18***	144	0.184**	4.24	4
Calvert Short-Term Government Fund	0.35	0.35	1.63	-1.11	0.47	-0.241	4.069	7.15**	125	0.221**	26.98	28.3
Commerce Short-Term Government Fund	0.43	0.45	2.56	-1.63	0.63	-0.096	3.715	4.319	189	0.144**	112.61	104.2
Davis Government Bond Fund	0.30	0.31	2.10	-3.51	0.78	-0.735	6.135	100.40***	201	0.156**	113.31	51.8
DFA LWAS/DFA Two-Year Government Portfolio	0.35	0.39	1.84	-0.82	0.38	0.337	6.254	78.70***	171	0.148*	105.75	108.7
Dreyfus Short-Intermediate Government Fund	0.36	0.35	2.49	-1.28	0.57	0.279	3.822	8.26**	201	0.213***	388.62	442.6
Excelsior Short-Term Government Securities Fund	0.39	0.40	1.65	-1.42	0.47	-0.116	4.040	8.047**	170	0.216***	181.93	67.9
Federated Government UltrashortDuratn Fund	0.29	0.28	1.03	-0.70	0.23	-0.346	5.330	38.89***	158	0.395***	493.40	302.25
GE Short-Term Government Fund	0.37	0.35	2.22	-0.82	0.46	0.353	4.222	16.44***	198	0.164**	56.37	64.45
Goldman Sachs Short Duration Government Fund	0.42	0.39	2.05	-0.92	0.53	0.205	3.212	1.782	201	0.225***	779.08	497.9
Homestead Short-Term Government Securities Fund	0.34	0.35	1.40	-0.70	0.36	-0.152	3.502	2.640	184	0.164**	34.77	37.5
Managers Short Duration Government Fund	0.35	0.36	1.82	-1.78	0.38	-0.754	9.246	345.72***	201	0.151**	135.54	117.9
MTB Short Duration Government Bond Fund	0.35	0.34	1.59	-0.97	0.40	-0.240	3.899	6.829**	158	0.113	118.84	106.7
Oppenheimer Limited-Term Government Fund	0.34	0.38	2.75	-5.60	0.71	-3.110	27.60	5392.54***	201	0.199***	1535.68	1629.8
Performance Short Term Government Income Fund	0.34	0.30	1.64	-0.76	0.44	0.230	3.133	1.933	201	0.272***	96.62	98.00
RiverSource Short Duration US Government Fund	0.33	0.36	2.24	-1.88	0.62	-0.305	3.603	6.158**	201	0.277***	1830.46	1791.80
RiverSource US Government Mortgage Fund	0.40	0.47	1.98	-2.30	0.80	-0.684	3.875	11.32***	103	0.196**	247.1	247.9
SEI Short-Duration Government Fund	0.39	0.40	1.95	-1.03	0.48	0.064	3.571	2.873	201	0.176**	175.18	120.90
Sentinel Short Maturity Government Fund	0.40	0.43	2.07	-1.10	0.46	-0.115	4.045	8.87**	186	0.073	336.32	160.40
Sit US Government Securities Fund	0.45	0.46	2.14	-1.58	0.57	-0.141	3.801	6.04**	201	0.123*	226.87	199.9

This table reports some descriptive statistics for monthly returns and total net assets (TNAs) of the USD Short-Term Government Bond funds over the period January 1994-September 2010. Specifically, for each of the funds it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality, the number of observations and first-order autocorrelation coefficient. In the last two columns it is reported the mean and median total net assets of the funds. ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table A.2: Descriptive statistics of USD Medium-Term Government Bond funds (Part I)

	Mean Return (%)	Median Return (%)	Max Return (%)	Min Return (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera	Obs.	r1	Mean TNA	Median TNA
ACM Government Opportunity Fund	0.63	0.85	6.18	-6.84	1.76	-0.619	4.95	34.71***	156	0.169**	106.58	107.3
AIM US Government Fund	0.41	0.43	4.67	-3.11	1.05	0.055	4.660	23.19***	201	0.107	596.48	539.6
Allegiant Government Mortgage Fund	0.47	0.49	3.99	-2.38	0.78	0.045	5.099	36.95***	201	0.084	210.93	207.4
AllianceBernsteinUS Government Portfolio	0.36	0.45	4.01	-4.30	1.24	-0.589	4.248	20.35***	166	0.120	1142.59	1192.55
American Century Government Bond Fund	0.48	0.50	4.05	-2.43	1.08	-0.036	3.486	2.00	201	0.111	536.04	480.2
American Funds US Government Securities Fd	0.43	0.47	3.98	-2.78	1.05	-0.232	3.673	5.59*	201	0.136*	2584.39	1782.6
Asset Management US Government Mortgage Fund	0.36	0.42	5.06	-3.51	1.04	-0.176	5.304	45.51***	201	0.144**	96.55	78.3
AXA Enterprise Government Securities Fund	0.41	0.48	4.26	-2.83	1.07	-0.198	4.338	13.15***	162	0.287***	115.72	124.5
BB&T Intermediate US Government Fund	0.46	0.44	4.25	-2.89	1.13	0.051	3.912	7.00**	201	0.141**	246.57	187.8
BlackRock Intermediate Government Bond	0.44	0.48	2.87	-2.96	0.87	-0.388	4.062	14.42***	201	0.142**	381.63	361
BlackRock US Government Fund	0.41	0.49	2.79	-2.65	0.88	-0.423	3.577	6.69**	153	0.216***	1965.31	1882.7
BNY Mellon Intermediate US Government Fund	0.42	0.51	3.53	-3.28	1.00	-0.401	4.044	14.53***	201	0.146**	93.71	87.6
CaliforniaUS Government Bond Fund	0.28	0.27	1.64	-0.98	0.44	0.192	4.371	10.81***	128	0.184**	13.61	14.7
Capital One US Government Income Fund	0.41	0.45	3.10	-2.56	0.90	0.221	3.530	3.51	178	0.195***	73.49	82.8
CNI Government Bond	0.39	0.38	2.32	-3.07	0.75	-0.732	6.018	60.00***	128	0.036	42.51	26.75
DFA Five-Year Government Portfolio	0.41	0.40	3.20	-3.52	0.86	-0.742	6.926	147.5***	201	0.112	509.34	301
DFA Intermediate Government Fixed IncomePort	0.54	0.59	5.66	-5.59	1.52	-0.160	4.437	18.16***	201	0.104	514.63	307.3
Dunham Corporate/Government Bond Fund	0.44	0.51	3.14	-2.83	1.04	-0.113	3.615	1.24	69	0.165	67.63	75.6
Dupree Intermediate Government Bond Series	0.46	0.53	5.24	-3.45	1.13	0.120	5.343	46.47***	201	0.102	16.18	13.1
DWS Strategic Government Securities Fund	0.45	0.51	4.02	-2.82	0.91	-0.078	4.558	20.54***	201	0.152**	3294.13	3194.6
Eaton Vance Government Obligations Fund	0.40	0.37	3.19	-1.78	0.83	0.077	3.453	1.92***	201	0.091	693.38	541.2
Evergreen US Government Fund	0.39	0.47	3.36	-2.74	1.01	-0.344	3.282	4.562	198	0.162**	485.41	475.9
Federated Fund for US Government Securities	0.43	0.50	2.43	-2.12	0.81	-0.339	3.166	4.083	201	0.148**	1165.95	1181.8
Federated Government Income Securities	0.44	0.50	2.53	-2.72	1.02	-0.307	3.081	3.202	201	0.085	1214.51	1038.4
Federated Intmdt Government Fund	0.38	0.37	3.36	-1.94	0.58	0.534	7.806	202.998***	201	0.086	153.07	94.8
Fidelity Intermediate Government Income Fund	0.46	0.48	3.12	-2.93	0.90	-0.259	4.009	10.76***	201	0.121*	955.86	848.8
Fifth Third US Government Bond Fund	0.39	0.40	2.83	-2.85	0.87	-0.408	3.853	9.644***	166	0.144*	50.80	48.95
First American Intermediate Government Bond	0.34	0.41	3.52	-2.43	0.97	0.118	4.377	7.230**	95	-0.003	141.10	97.5
First American US Government Mortgage Fund	0.41	0.49	3.79	-2.65	0.86	-0.346	4.537	22.85***	193	0.215***	141.65	120.2
First Investors Government Fund	0.42	0.47	3.41	-2.77	0.86	-0.160	4.182	12.55***	201	0.142**	200.2	197.2
GE Government Securities Fund	0.37	0.56	4.50	-4.49	1.27	-0.424	4.112	16.39***	201	0.120*	393.51	221.8

This table reports some descriptive statistics for monthly returns and total net assets (TNAs) of the USD Medium-Term Government Bondfunds over the period January 1994-September 2010. Specifically, for each of the funds it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality, the number of observations and first-order autocorrelation coefficient. In the last two columns it is reported the mean and median total net assets of the funds. ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table A.2: Descriptive statistics of USD Medium-Term Government Bondfunds (Part II)

	Mean Return (%)	Median Return (%)	Max Return (%)	Min Return (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera	Obs.	r1	Mean TNA	Median TNA
Flex-funds US Government Bond Fund	0.38	0.35	5.09	-3.85	1.27	-0.041	5.107	37.23***	201	0.186***	12.9	13.2
Franklin US Government Securities Fund	0.47	0.54	3.41	-2.81	0.86	-0.199	4.536	21.09***	201	0.152**	8733.03	8631.2
Goldman Sachs Government Income Fund	0.47	0.53	3.88	-3.15	1.05	-0.198	3.995	9.60***	201	0.108	423.75	256.6
HartfordUS Government Securities HLS	0.40	0.39	3.70	-3.33	1.03	-0.534	4.366	25.18***	201	0.225***	0.1	0.1
Hartford US Government Securities Fund	0.43	0.49	3.07	-4.38	1.09	-0.512	4.453	23.95***	182	0.050	112.59	86.00
HuntingtonIntmdt Government Income Fund	0.42	0.43	4.21	-3.34	0.95	-0.116	4.747	26.02***	201	0.102	105.39	111.3
JennDry Dryden Government Income Fund	0.45	0.52	4.37	-3.99	1.19	-0.375	3.991	12.94***	201	0.125*	720	718
John Hancock Government Income Fund	0.44	0.50	4.41	-4.27	1.20	-0.371	4.341	19.68***	201	0.113	496.4	498
Legg Mason Partners Government Securities Fund	0.43	0.54	5.03	-3.58	1.19	-0.204	4.220	13.85***	201	0.078	672.22	635.5
Madison Mosaic Government Fund	0.37	0.40	3.07	-2.79	0.95	-0.105	3.817	5.96*	201	0.196***	5.22	5.3
Managers Intermediate Duration Government Fund	0.50	0.57	3.19	-2.78	0.88	-0.310	3.769	8.177**	201	0.149**	94.59	54.9
Marshall Government Income Fund	0.47	0.52	3.17	-3.77	0.91	-0.476	4.934	38.92***	201	0.170**	346.14	370
MFS Government Securities Fund	0.46	0.56	4.15	-3.62	1.11	-0.247	4.124	12.63***	201	0.130*	965.58	986.6
Morgan Stanley US Government Securities Trust	0.40	0.50	3.53	-2.81	1.10	-0.367	3.650	8.04**	201	0.127*	4746.56	4537.5
MTB US Government Bond Fund	0.45	0.50	4.25	-3.14	1.11	-0.172	3.606	4.07	201	0.126*	100.55	80.4
Nationwide Government Bond Fund	0.49	0.51	4.66	-3.51	1.16	-0.083	3.918	7.29**	201	0.098	122.41	130
Northern Short-Intermediate US Government Fund	0.36	0.37	2.47	-1.68	0.69	-0.200	3.829	4.63*	131	0.097	268.48	161.7
Northern US Government Fund	0.42	0.42	3.38	-2.48	0.85	-0.130	3.978	8.579**	201	0.127*	290.45	264.9
Payden US Government Fund	0.45	0.44	3.13	-2.11	0.74	-0.118	4.314	13.96***	188	0.188***	56.41	58.30
Pioneer Government Income Fund	0.46	0.45	3.37	-2.29	0.90	-0.100	3.470	2.19	201	0.109	155.37	202.9
Principal Government & High Quality Bond Fund	0.43	0.53	4.37	-2.90	0.99	-0.151	4.519	20.09***	201	0.167**	553.7	393.6
Putnam American Government Income Fund	0.48	0.51	6.17	-3.50	1.25	-0.044	5.519	53.20***	201	0.203***	1385.74	1526.8
Putnam Limited Duration Government Income Fund	0.40	0.43	2.34	-2.51	0.80	-0.447	3.621	8.20**	166	0.195**	498.1	465.55
Putnam US Government Income Trust	0.48	0.49	6.44	-4.73	1.14	-0.125	9.478	351.99***	201	0.349***	2735.71	2806.1
RidgeWorth US Government Securities Fund	0.48	0.53	4.61	-3.52	1.13	-0.221	4.325	15.85***	195	0.095	212.32	176.4
SEI Intermediate-Duration Government Fund	0.49	0.53	5.07	-2.75	1.02	0.224	4.917	32.46***	201	0.104	123.76	114
Scudder Intermediate Government Trust	0.46	0.54	3.79	-3.81	1.13	-0.519	4.318	16.30***	139	0.142*	259.38	257.1
Seligman US Government Securities Fund	0.38	0.35	4.09	-3.57	1.25	0.019	3.279	0.62	187	0.137*	90.84	76.6
Sentinel Government Securities Fund	0.49	0.56	3.80	-3.01	1.11	-0.409	4.046	14.77***	201	0.099	199.48	105.5
Stratus Government Securities Portfolio	0.39	0.36	3.07	-1.66	0.75	0.159	4.389	17.00***	201	0.166**	39.47	43.3
Thornburg Limited Term US Government Fund	0.41	0.38	2.74	-2.75	0.83	-0.237	3.920	8.97**	201	0.106	173.54	146.6
Value Line US Government Securities Fund	0.41	0.50	3.59	-3.28	1.12	-0.380	3.952	12.43***	201	0.201***	158.67	144
Virtus Intermediate Government Bond Fund	0.49	0.57	3.35	-3.69	1.01	-0.384	4.503	19.23***	162	0.032	58.17	61.7

This table reports some descriptive statistics for monthly returns and total net assets (TNAs) of the USD Medium-Term Government Bondfunds over the period January 1994-September 2010. Specifically, for each of the funds it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality, the number of observations and first-order autocorrelation coefficient. In the last two columns it is reported the mean and median total net assets of the funds. ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table A.2: Descriptive statistics of USD Medium-Term Government Bond funds (Part III)

	Mean Return (%)	Median Return (%)	Max Return (%)	Min Return (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera	Obs.	r1	Mean TNA	Median TNA
Williamsburg Government Street Bond Fund	0.42	0.41	3.22	-2.12	0.82	-0.130	3.920	6.476**	170	0.215***	42.21	42.1
SM&R Government Bond Fund	0.38	0.43	4.94	-2.44	0.97	0.358	5.117	40.78***	196	0.142**	26.17	27.15
Van Kampen Government Securities Fund	0.39	0.39	3.54	-2.85	1.14	-0.271	3.222	2.87	201	0.137*	1709.01	1478.1
Waddell & Reed Government Securities Fund	0.44	0.50	4.10	-2.81	1.12	-0.117	3.680	4.34	201	0.123*	236.89	222.6
WesMark Government Bond Fund	0.38	0.37	0.345	-1.95	0.83	0.273	4.369	13.49***	149	0.083	176.27	187.4

This table reports some descriptive statistics for monthly returns and total net assets (TNAs) of the USD Medium-Term Government Bondfunds over the period January 1994-September 2010. Specifically, for each of the funds it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality, the number of observations and first-order autocorrelation coefficient. In the last two columns it is reported the mean and median total net assets of the funds. ***Significant at 1%; **Significant at 5%; *Significant at 10%

Table A.3: Descriptive statistics of USD Long-Term Government Bond funds

	Mean Return (%)	Median Return (%)	Max Return (%)	Min Return (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera	Obs.	r1	Mean TNA	Median TNA
BlackRock Government Income Portfolio	0.52	0.59	5.05	-4.62	1.44	-0.1	4.055	9.17**	191	0.063	468.88	118.5
California US Government Securities Fund	0.41	0.46	4.33	-4.13	1.46	-0.356	3.843	10.19***	201	0.140**	29.8	29.5
Federated US Government Bond Fund	0.60	0.68	11.83	-9.09	2.65	0.092	5.862	68.87***	201	-0.008	98.8	97.7
Fidelity Government Income Fund	0.48	0.54	4.32	-4.20	1.24	-0.331	4.169	15.10***	201	0.102	3209.19	2684.2
JPMorgan Government Bond Fund	0.51	0.58	4.83	-3.69	1.23	-0.172	3.711	5.22*	201	0.058	928.25	988.7
MainStay Government Fund	0.40	0.44	4.47	-4.08	1.16	-0.231	4.348	17.01***	201	0.094	551.75	476.4
Oppenheimer US Government Trust	0.45	0.50	5.64	-4.46	1.14	-0.253	6.192	87.48***	201	0.074	902.65	899.5
Pacific Advisors Government Securities Fund	0.33	0.29	5.19	-8.76	1.48	-0.744	10.904	541.76***	201	0.146**	7.08	5.8
PIMCO Long-Term US Government Fund	0.70	0.74	9.63	-8.95	2.69	-0.118	3.977	8.468**	201	0.028	705.08	603.5
Rydex Government Long Bond 1.2x Strategy Fund	0.14	0.72	18.39	-25.38	5.46	-0.902	8.373	267.64***	200	-0.023	63.58	51.8
SunAmerica US Government Securities Fund	0.44	0.55	5.10	-5.56	1.23	-0.485	6.124	89.64***	201	0.081	312.74	238.3

This table reports some descriptive statistics for monthly returns and total net assets (TNAs) of the USD Long-Term Government Bond funds over the period January 1994-September 2010. Specifically, for each of the funds it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality, the number of observations and first-order autocorrelation coefficient. In the last two columns it is reported the mean and median total net assets of the funds. ***Significant at 1%; **Significant at 5%; *Significant at 10%

FIGURES

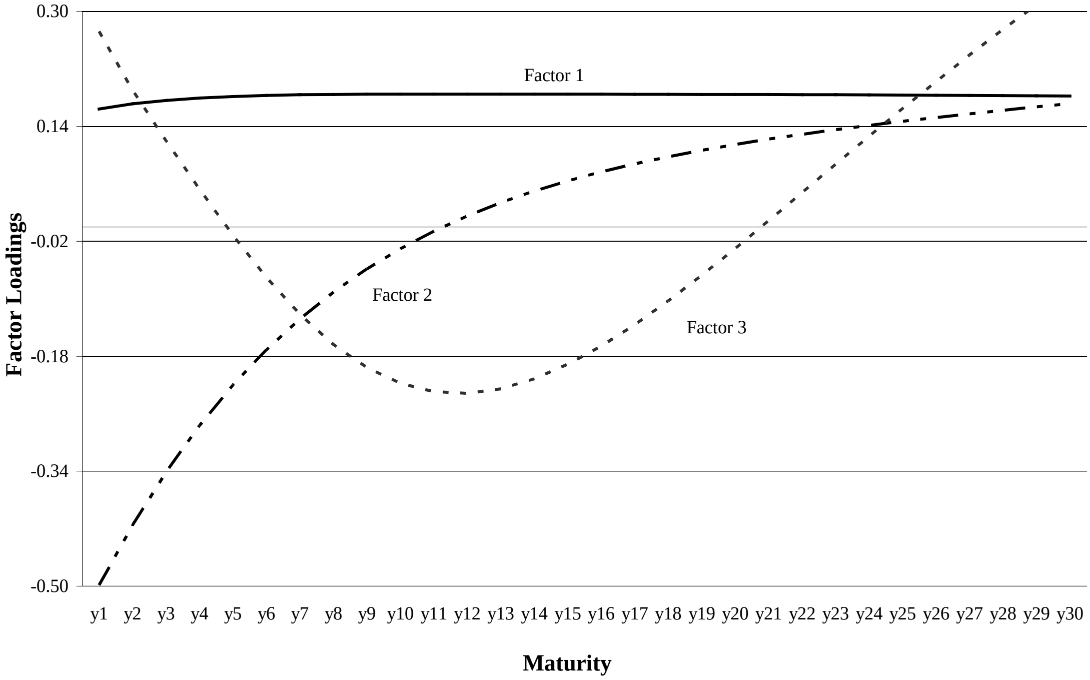

Fig.1Three most important factor loadings driving the zero-coupon yield curve.

Fig. 1 plots the three most important factors loadings driving the zero-coupon yield curve. These factor loadings are obtained from the Principal Component analysis of monthly observations of the database of U.S. zero-coupon yields constructed by Gurkaynak et al. (2007) in the period November 1985 to September 2010.

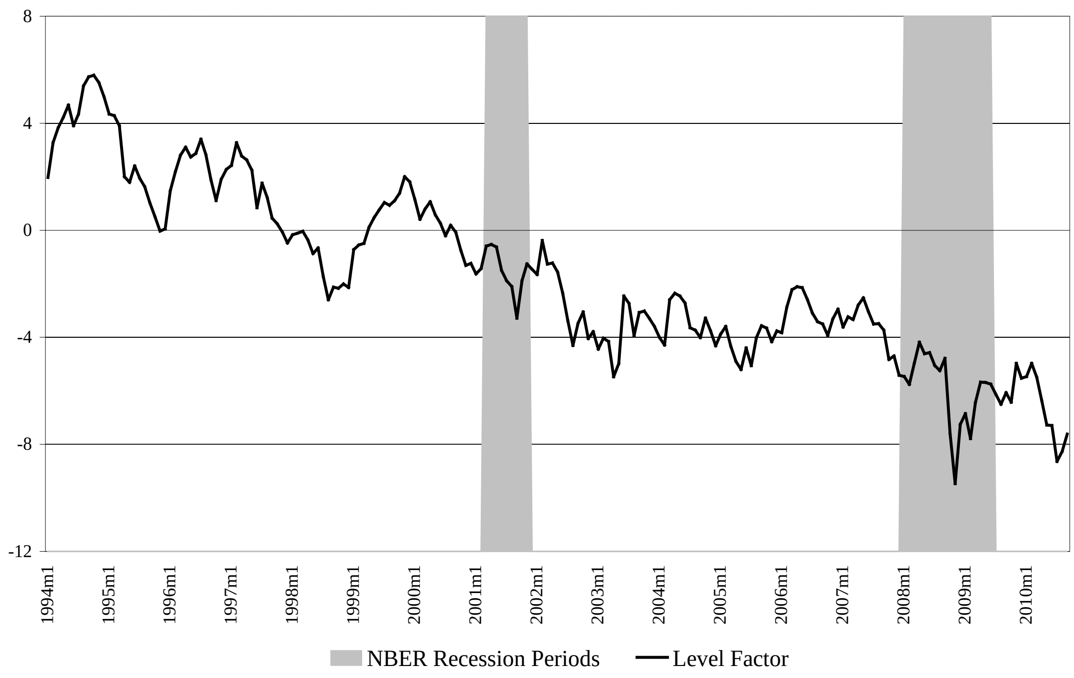

Fig.2"Level" factor of zero-coupon yield curve.

Fig. 2 plots the "level" factor of the zero-coupon yield curve. This is the first factor obtained from the Principal Component analysis of monthly observations of the database of U.S. zero-coupon yields constructed by Gurkaynak et al. (2007) in the period November 1985 to September 2010.Shadings denote months designated as recessions by the National Bureau of Economic Research.

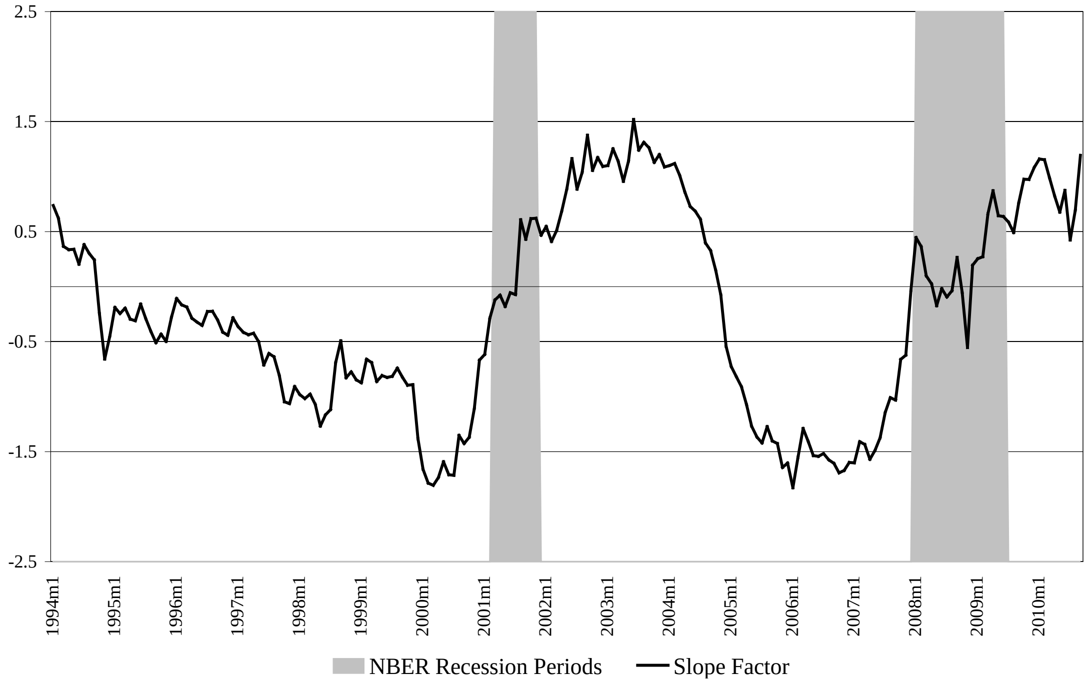

Fig.3"Slope" factor of zero-coupon yield curve.

Fig. 3 plots the "slope" factor of the zero-coupon yield curve. This is the second factor obtained from the Principal Component analysis of monthly observations of the database of U.S. zero-coupon yields constructed by Gurkaynak et al. (2007) in the period November 1985 to September 2010. Shadings denote months designated as recessions by the National Bureau of Economic Research.

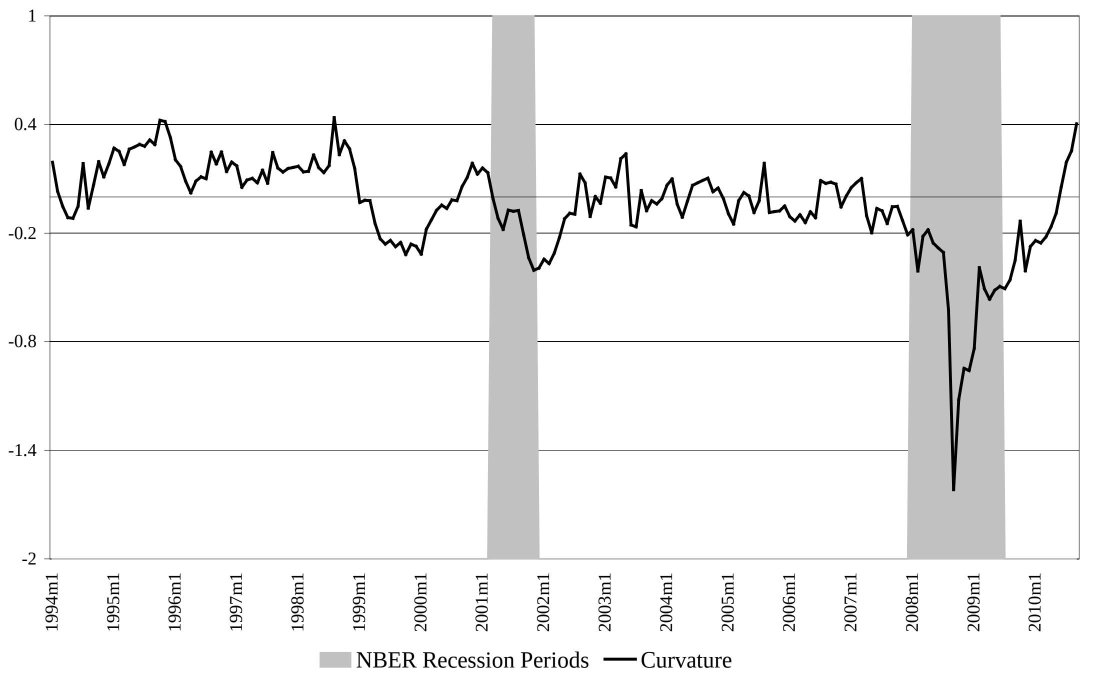

Fig.4“Curvature” factor of zero-coupon yield curve.

Fig. 4 plots the “curvature” factor of the zero-coupon yield curve. This is the third factor obtained from the Principal Component analysis of monthly observations of the database of U.S. zero-coupon yields constructed by Gurkaynak et al. (2007) in the period November 1985 to September 2010. Shadings denote months designated as recessions by the National Bureau of Economic Research.

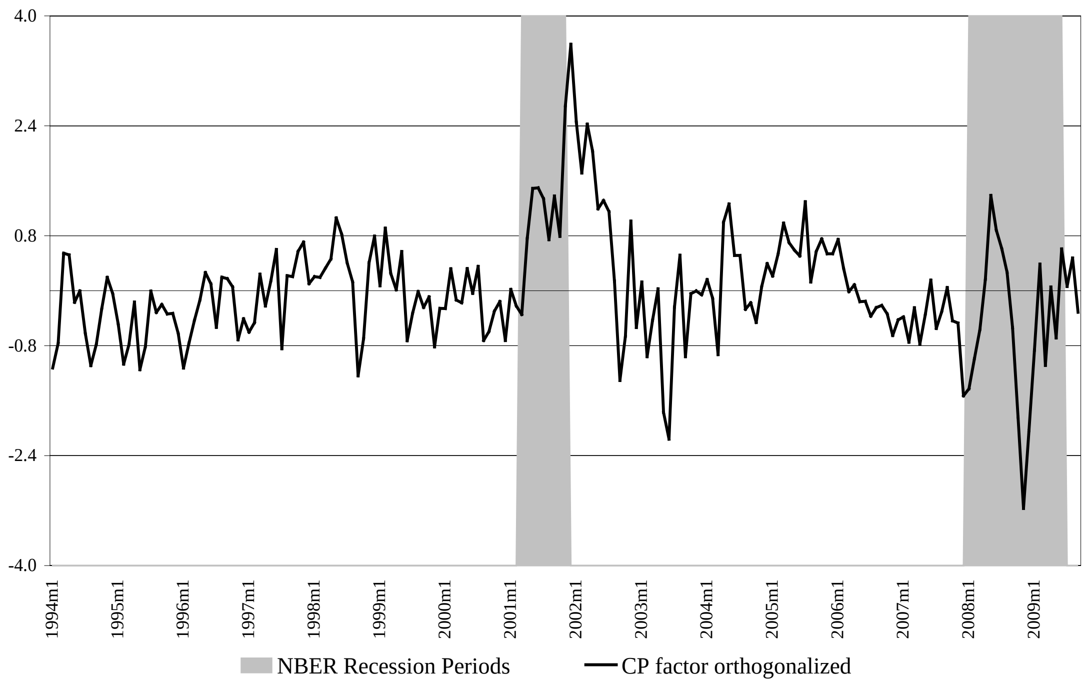

Fig.5 Cochrane and Piazessi (2005) factor orthogonalized to the "level", "slope" and "curvature" factors.

Fig. 5 plots the CP factor orthogonalized to the "level", "slope" and "curvature" factors. We use the Fama-Bliss dataset available from the Center for Research in Securities Prices (CRSP) that contains observations on one- through five-year zero-coupon U.S. Treasury bond prices covering the period between August 1965 and September 2010. We construct data on excess bond returns, yields, and forward rates, as described in Cochrane and Piazzesi (2005), and estimate the CP factor. Then, we run the regression of the CP factor (2005) on the "level" factor, the "slope" factor and the curvature "factor", and we consider the residual from this regression as the Cochrane and Piazzesi factor (2005) orthogonalized to the level, slope and curvature factor ($CP^{\perp}$).Shadings denote months designated as recessions by the National Bureau of Economic Research.

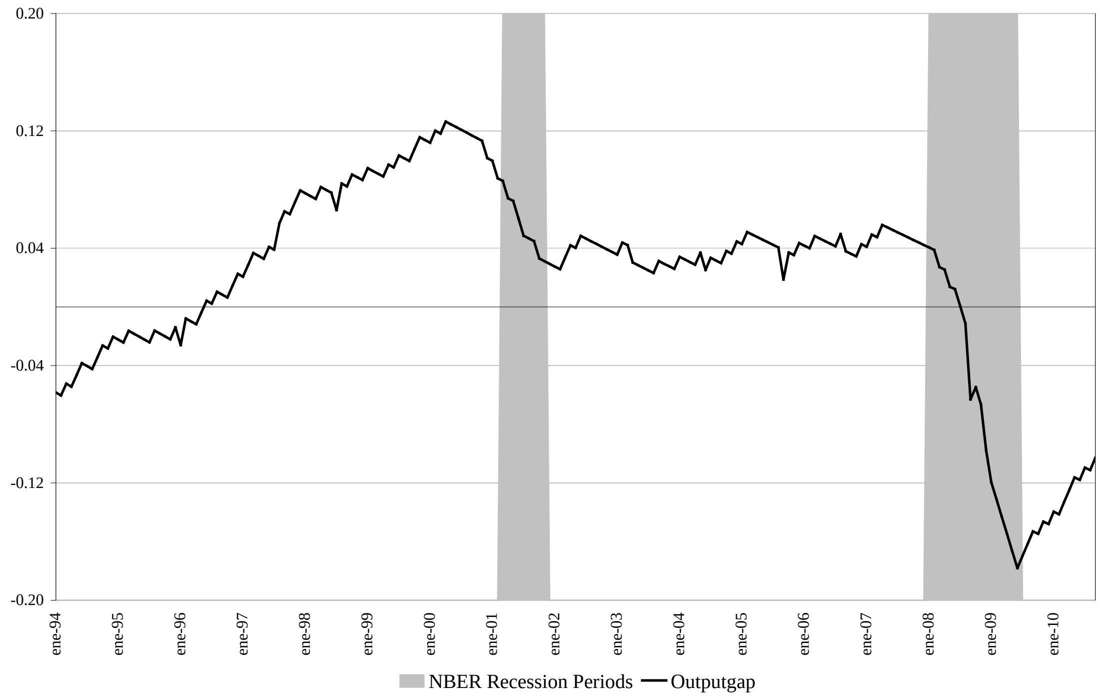

Fig. 6 Output gap.

Fig. 6 plots the output gap in the period January 1994 to September 2010. We estimate the output gap following the Cooper and Priestly (2009) main measure of the output gap (see eqn. 1) applied to the Industrial Production Index obtained form the US Federal Reserve web (http://www.federalreserve.gov/econresdata/statisticsdata.htm). The estimation period is August 1965 to September 2010.Shadings denote months designated as recessions by the National Bureau of Economic Research.

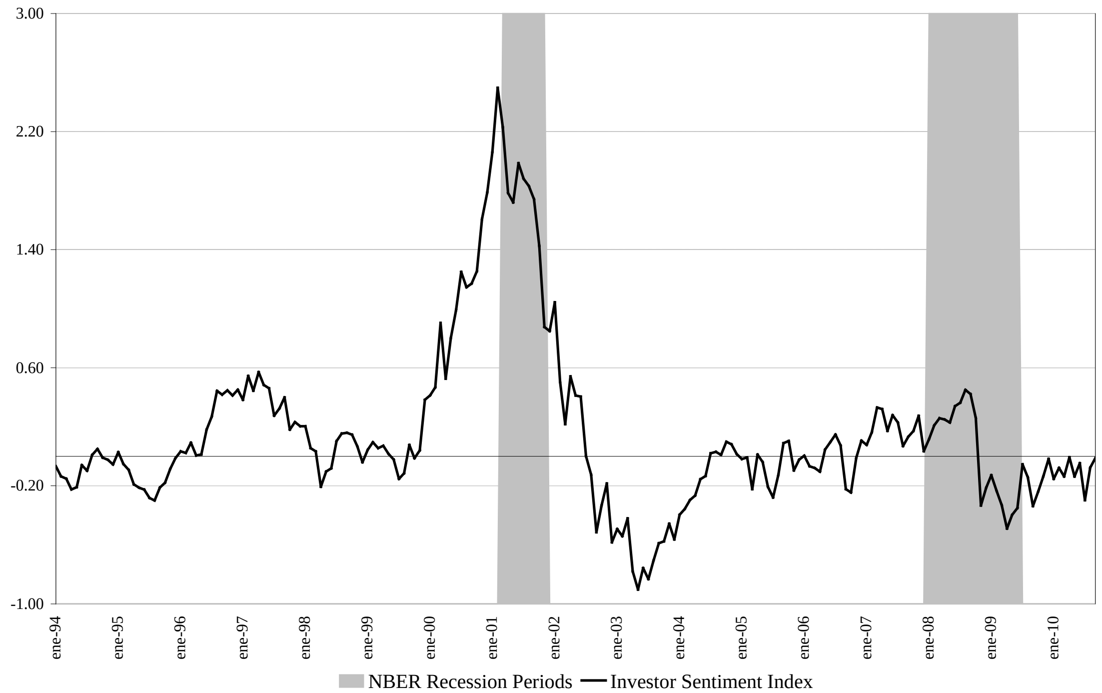

Fig.7 Investor sentiment index.

Fig. 7 plots the investor sentiment index created by Baker and Wurgler (2006) and available at the Wurgler' web page (http://pages.stern.nyu.edu/~jwurgler/) in the period January 1994 to September 2010. Shadings denote months designated as recessions by the National Bureau of Economic Research.

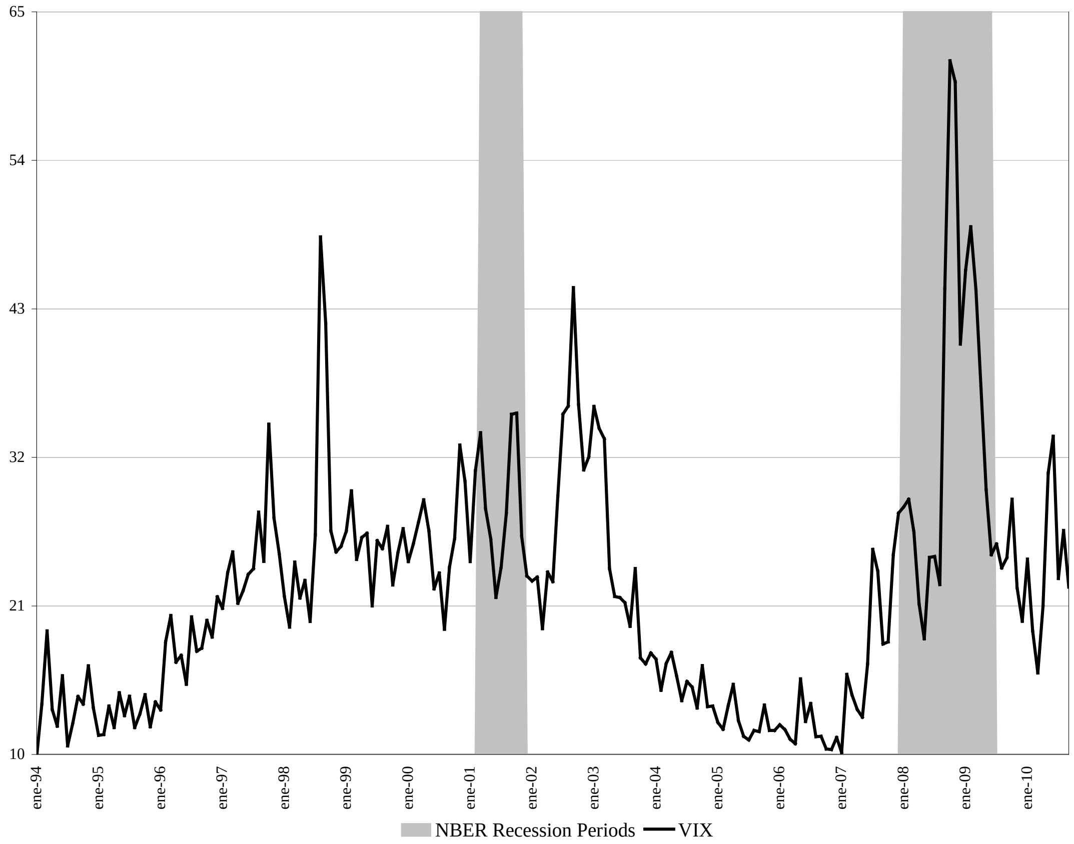

Fig.8 VIX.

Fig. 8 plots the VIX in the period January 1994 to September 2010. Shadings denote months designated as recessions by the National Bureau of Economic Research.

TABLES

Table 1: Summary statistics of Bank of America Merrill Lynch U.S. Year Treasury Indexes monthly returns[a]

IndexName	Mean (%)	Median (%)	Max (%)	Min (%)	Volatility (%)	Skewness	Kurtosis	Jarque-Bera
The Bank of America Merrill Lynch 1-3 U.S. Year Treasury Index	0.390	0.375	1.732	-0.969	0.478	0.085	3.475	2.13
The Bank of America Merrill Lynch 3-5 U.S. Year Treasury Index	0.485	0.531	3.428	-2.864	1.078	-0.188	3.457	2.93
The Bank of America Merrill Lynch 5-7 U.S. Year Treasury Index	0.532	0.559	5.340	-3.561	1.418	-0.138	3.544	3.12
The Bank of America Merrill Lynch 7-15 U.S. Year Treasury Index	0.564	0.618	8.386	-6.327	1.928	-0.086	4.608	21.89***
The Bank of America Merrill Lynch >15 U.S. Year Treasury Index	0.634	0.874	13.127	-11.87	3.011	-0.196	6.037	78.54***

[a]This table reports some descriptive statistics for monthly returns of the Bank of America Merrill Lynch US Year Treasury Indexes used for building the benchmarks over the period January 1994 to September 2010. Specifically, for each of the indexes it is provided the mean, median, maximum, minimum, volatility, skewness and kurtosis of the monthly returns. We also report the Jarque-Bera test for normality and the number of observations.

***Significant at 1%; **Significant at 5%; *Significant at 10%.

Table 2: Relative importance of factors: U.S. zero-coupon yield curve analysis [b]

	Proportion of total explained variance accounted by
1º Factor	96.9%
2º Factor	99.6%
3º Factor	99.9%

[b]This table reports the relative importance of the first three factors to explain the zero-coupon yield curve, applying Principal Component analysis to monthly observations of the database of U.S. government zero-coupon yields constructed by Gurkaynak et al. (2007). This database contains maturities up to thirty years at daily frequency in the period November 1985 to September 2010.

Table 3: Summary statistics of state variables [c]

IndexName	Mean (%)	Median (%)	Max (%)	Min (%)	STD(%)	Skewness	Kurtosis
Level Factor	-1.76	-2.17	5.80	-9.47	3.28	0.23	-0.58
Slope Factor	-0.25	-0.29	1.52	-1.83	0.91	0.06	-1.12
Curvature Factor	-0.05	-0.02	0.44	-1.62	0.27	-1.85	7.03
$CP^{\perp}$	0.00	-0.01	3.59	-3.17	0.85	0.43	2.72
VIX	22.11	21.67	61.38	9.82	9.08	1.31	2.77
Output gap	1.93	3.67	12.63	-17.81	6.92	-1.09	0.84
Investor Sentiment	0.15	0.02	2.50	-0.90	0.57	1.78	3.87
One-month lagged benchmark	0.37	0.36	1.62	-0.91	0.43	-0.09	0.47

[c] This table reports some descriptive statistics for the state variables over the period January 1994 to September 2010. Specifically, for each of the state variables it is provided the mean, median, maximum, minimum, standard deviation, skewness and kurtosis.

Table 4: Optimal unconditional U.S. government bond funds weight [d]

	Short-Term Bond mutual Funds	**Medium-Term Bond mutual Funds**	**Long-Term Bond mutual Funds**
Meanα_F	-0.988	-2.299	-1.257
Medianα_F	-1.502	-2.581	-1.351
Maximumα_F	8.881	10.143	1.373
Minimumα_F	-7.286	-29.116	-5.411
Standard Deviationα_F	5.159	4.912	2.114
% of Positiveα_F	45.83%	30.43%	27.27%
% of Positive and Significant α_F	4.17%	4.35%	0.00%
% of Negative α_F	54.17%	69.57%	72.73%
% of Negative and Significant α_F	20.83%	24.64%	18.18%

[d]This table reports summary statistics (mean, median, maximum and minimum) of the optimal unconditional government bond funds weight, α_F , allocated to USD short, intermediate and long term government bond funds, that assumes a constant portfolio weight in the considered sample. The table also reports the % of funds with optimal unconditional positive and negative weight and the degree of significance.

Table 5: Optimal conditional portfolios: U.S. short term government bond funds weight [e]

	Level	**Slope**	**Curvature**	**CP**	**VIX**	**Outputgap**	**Investor Sentiment**	**One-month lagged benchmark**
Mean Coefficient	-2.531	1.056	44.414	3.014	0.548	-2.733	17.708	-5.754
Median Coefficient	-2.530	-0.299	33.253	2.661	0.510	-2.824	13.156	-2.274
% of Funds with positive coefficient	20.83%	50.00%	100.00%	75.00%	66.67%	4.17%	91.67%	41.67%
% of Funds with positive and significant coefficient	8.33%	8.33%	50.00%	8.33%	33.33%	0.00%	41.67%	4.17%
% of Funds with negative coefficient	79.17%	50.00%	0.00%	25.00%	33.33%	95.83%	8.33%	58.33%
% of Funds with negative and significant coefficient	25.00%	12.50%	0.00%	4.17%	4.17%	70.83%	4.17%	8.33%

[e] This table reports the relationship between the optimal weight allocated to the USDSTBF and the state variables (see eqn. 14). The first and second rows display the mean and median coefficient for each state variable across funds. We select the U.S. government bond funds provided by Thomson-Reuters as “USD short term bond funds” in the period January 1994 to September 2010.

Table 6: Optimal conditional portfolios: U.S. intermediate government bond funds weight [f]

	Level	Slope	Curvature	CP	VIX	Outputgap	Investor Sentiment	One-month lagged benchmark
Mean Coefficient	-1.795	0.197	18.815	2.900	0.320	-1.300	6.612	0.757
Median Coefficient	-1.352	-0.194	16.185	4.084	0.275	-1.151	4.670	2.500
% of Funds with positive coefficient	7.25%	49.28%	94.20%	81.16%	76.81%	7.25%	73.91%	76.81%
% of Funds with positive and significant coefficient	1.45%	5.80%	52.17%	14.49%	7.25%	1.45%	21.74%	11.59%
% of Funds with negative coefficient	92.75%	50.72%	5.80%	18.84%	23.19%	92.75%	26.09%	23.19%
% of Funds with negative and significant coefficient	31.88%	0.00%	0.00%	2.90%	0.00%	55.07%	2.90%	4.35%

[f] This table reports the relationship between the optimal weight allocated to the USDMTBF and the state variables (see eqn. 14). The first and second rows display the mean and median coefficient for each state variable across funds. We select the U.S. government bond funds provided by Thomson-Reuters as "USD intermediate term bond funds" in the period January 1994 to September 2010.

Table 7: Optimal conditional portfolios: U.S. long term government bond funds weight [g]

	Level	**Slope**	**Curvature**	**CP**	**VIX**	**Outputgap**	**Investor Sentiment**	**One-month lagged benchmark**
Mean Coefficient	-1.449	-1.088	16.984	3.253	0.174	-1.165	2.625	1.231
Median Coefficient	-1.016	-1.757	18.380	3.470	0.177	-1.427	2.275	0.607
% of Funds with positive coefficient	9.09%	27.27%	100.00%	90.91%	72.73%	0.00%	54.55%	72.73%
% of Funds with positive and significant coefficient	0.00%	9.09%	63.64%	18.18%	18.18%	0.00%	9.09%	27.27%
% of Funds with negative coefficient	90.91%	72.73%	0.00%	9.09%	27.27%	100.00%	45.45%	27.27%
% of Funds with negative and significant coefficient	18.18%	18.18%	0.00%	0.00%	0.00%	54.55%	0.00%	0.00%

[g]This table reports the relationship between the optimal weight allocated to the USDLTBF and the state variables (see eqn. 14). The first and second rows display the mean and median coefficient for each state variable across funds. We select the U.S. government bond funds provided by Thomson-Reuters as "USD bond funds" in the period January 1994 to September 2010

Table 8: Summary statistics of USDSTBF, USDMTBF and USLTDBF optimal portfolio performance and the average optimal conditional weight.[h]

Panel A: All period	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.49%	0.60%	0.60%
Average optimal excess equivalent certainty on benchmark	0.47%	0.54%	0.50%
Mean average weight	0.400	0.424	0.389
Median average weight	0.425	0.443	0.340
Maximum average weight	0.658	0.809	0.724
Minimum average weight	0.121	0.112	0.071
Standard deviation average weight	0.162	0.162	0.213
Panel B: Crisis periods	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	1.37%	1.43%	1.66%
Average optimal excess equivalent certainty on benchmark	1.34%	1.35%	1.66%
Mean average weight	0.705	0.668	0.470
Median average weight	0.722	0.660	0.563
Maximum average weight	1.000	1.000	0.863
Minimum average weight	0.222	0.148	0.000
Standard deviation average weight	0.199	0.215	0.309

[h]The table reports the average optimal portfolios excess return and equivalent certainty on the benchmark.This table also reports the summary statistics of the average optimal weight allocated to all the USDSTBF, USDMTBF and USDLTBF (see eqn. 14). We select the U.S. government bond funds provided by Thomson-Reuters as “USD short intermediate term and bond funds” in the period January 1994-September 2010.Panel A shows the results for all the period analyzed and Panel B reports the results for NBER U.S. recession periods in the sample.

Table 9: Summary statistics of the average optimal USDSTBF, USDMTBF and USLTDBF conditional weight and optimal portfolio performance (First quartile)[i]

Panel A: All period	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.987%	1.195%	1.100%
Average optimal excess equivalent certainty on benchmark	0.916%	1.080%	0.927%
Mean average weight	0.566	0.527	0.473
Median average weight	0.578	0.518	0.455
Maximum average weight	0.658	0.809	0.625
Minimum average weight	0.471	0.317	0.340
Standard deviation average weight	0.074	0.141	0.143
Panel B: Crisis periods	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	1.827%	2.518%	2.258%
Average optimal excess equivalent certainty on benchmark	1.679%	2.335%	2.795%
Mean average weight	0.768	0.684	0.437
Median average weight	0.759	0.659	0.563
Maximum average weight	1.000	1.000	0.634
Minimum average weight	0.609	0.386	0.114
Standard deviation average weight	0.140	0.189	0.282

[i]The table reports the average optimal portfolios excess return and equivalent certainty on the benchmark. This table also reports the summary statistics of the average optimal weight allocated to all the USDSTBF, USDMTBF and USDLTBF (see eqn. 14). We select the U.S. government bond funds provided by Thomson-Reuters as "USD short intermediate term and bond funds" in the period January 1994-September 2010.Panel A shows the results for all the period analyzed and Panel B reports the results for NBER U.S. recession periods in the sample. This table reports the results for the first quartile of funds according to the optimal portfolio equivalent certainty on the benchmark in annualized terms (the funds with the best CER) for each of the categories analyzed.

Table 10: Summary statistics of the average optimal USDSTBF, USDMTBF and USLTDBF conditional weight and optimal portfolio performance (Second quartile)[j]

Panel A: All period	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.481%	0.585%	0.455%
Average optimal excess equivalent certainty on benchmark	0.499%	0.518%	0.510%
Mean average weight	0.480	0.453	0.524
Median average weight	0.439	0.460	0.572
Maximum average weight	0.641	0.650	0.724
Minimum average weight	0.407	0.234	0.276
Standard deviation average weight	0.090	0.106	0.227
Panel B: Crisis periods	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	1.747%	1.498%	1.707%
Average optimal excess equivalent certainty on benchmark	1.803%	1.433%	2.102%
Mean average weight	0.776	0.755	0.606
Median average weight	0.774	0.792	0.707
Maximum average weight	1.000	1.000	0.741
Minimum average weight	0.481	0.371	0.370
Standard deviation average weight	0.183	0.191	0.205

[j]The table reports the average optimal portfolios excess return and equivalent certainty on the benchmark.This table also reports the summary statistics of the average optimal weight allocated to all the USDSTBF, USDMTBF and USDLTBF (see eqn. 14). We select the U.S. government bond funds provided by Thomson-Reuters as “USD short intermediate term and bond funds” in the period January 1994-September 2010.Panel A shows the results for all the period analyzed and Panel B reports the results for NBER U.S. recession periods in the sample. This table reports the results for the second quartile of funds according to the optimal portfolio equivalent certainty on the benchmark in annualized terms for each of the categories analyzed.

Table 11: Summary statistics of the average optimal USDSTBF, USDMTBF and USLTDBF conditional weight and optimal portfolio performance (Third quartile)[k]

Panel A: All period	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.341%	0.378%	0.509%
Average optimal excess equivalent certainty on benchmark	0.321%	0.356%	0.334%
Mean average weight	0.366	0.417	0.160
Median average weight	0.415	0.430	0.074
Maximum average weight	0.449	0.788	0.335
Minimum average weight	0.227	0.187	0.071
Standard deviation average weight	0.101	0.160	0.151
Panel B: Crisis periods	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	1.203%	0.897%	2.309%
Average optimal excess equivalent certainty on benchmark	1.183%	0.921%	1.519%
Mean average weight	0.667	0.644	0.425
Median average weight	0.685	0.662	0.369
Maximum average weight	0.852	0.963	0.863
Minimum average weight	0.373	0.148	0.044
Standard deviation average weight	0.187	0.237	0.413

[k]The table reports the average optimal portfolios excess return and equivalent certainty on the benchmark.This table also reports the summary statistics of the average optimal weight allocated to all the USDSTBF, USDMTBF and USDLTBF (see eqn. 14). We select the U.S. government bond funds provided by Thomson-Reuters as “USD short intermediate term and bond funds” in the period January 1994-September 2010.Panel A shows the results for all the period analyzed and Panel B reports the results for NBER U.S. recession periods in the sample. This table reports the results for the third quartile of funds according to the optimal portfolio equivalent certainty on the benchmark in annualized terms for each of the categories analyzed.

Table 12: Summary statistics of the average optimal USDSTBF, USDMTBF and USLTDBF conditional weight and optimal portfolio performance (Fourth quartile)[l]

Panel A: All period	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.151%	0.205%	0.216%
Average optimal excess equivalent certainty on benchmark	0.139%	0.176%	0.089%
Mean average weight	0.190	0.293	0.405
Median average weight	0.190	0.231	0.405
Maximum average weight	0.250	0.600	0.527
Minimum average weight	0.121	0.112	0.282
Standard deviation average weight	0.048	0.151	0.173
Panel B: Crisis periods	**Short -Term Bond mutual Funds**	**Medium- Term Bond mutual Funds**	**Long- Term Bond mutual funds**
Average optimal excess return on benchmark	0.687%	0.733%	-0.257%
Average optimal excess equivalent certainty on benchmark	0.684%	0.648%	-0.485%
Mean average weight	0.607	0.587	0.382
Median average weight	0.589	0.628	0.382
Maximum average weight	0.944	0.963	0.764
Minimum average weight	0.222	0.275	0.000
Standard deviation average weight	0.264	0.223	0.540

[l]The table reports the average optimal portfolios excess return and equivalent certainty on the benchmark.This table also reports the summary statistics of the average optimal weight allocated to all the USDSTBF, USDMTBF and USDLTBF (see eqn. 14). We select the U.S. government bond funds provided by Thomson-Reuters as “USD short intermediate term and bond funds” in the period January 1994-September 2010.Panel A shows the results for all the period analyzed and Panel B reports the results for NBER U.S. recession periods in the sample. This table reports the results for the fourth quartile of funds according to the optimal portfolio equivalent certainty on the benchmark in annualized terms (the funds with the worst CER) for each of the categories analyzed.