On an adaptive Black–Litterman investment strategy using conditional fundamentalist information: A Brazilian case study

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ABSTRACT

We propose an investment strategy based on the Black–Litterman model with conditional information. We present how observed price-earnings ratio and past returns can be used to determine 1-step ahead returns, considering investors with different risk profiles. The provided approach updates the conditional probability distribution of asset returns and mitigates asset allocation instability due to estimation errors. Our case study using Brazilian data shows the resulting optimal portfolios outperform traditional mean-variance portfolios even in an emerging market with one of the highest nominal interest rates.

1. Introduction

The practical problems in using the Markowitz model¹ motivated Fisher Black and Robert Litterman to develop a new model in the early 1990s (Black and Litterman, 1992). Their specification considered two different sources of information on assets’ expected returns, which are combined in one simple formula. The first is related to subjective views held by investment managers. The second is obtained quantitatively, from the market equilibrium returns. Such framework could provide more intuitive portfolios by computing a better estimate for the assets’ expected returns. Several authors have presented encouraging results when combining equilibrium returns with investment strategies using the BL framework. They provide evidence that the resulting optimal portfolios could achieve significant outperformances compared to mean-variance (MV) models (Harris et al., 2017; Bessler et al., 2017).

This paper presents two different contributions to the literature on the BL model. We construct the investors’ views emulating the decision rule made by typical fundamental analysts by presenting an autoregressive model using price-earnings data and past returns to predict one-step ahead returns (by changing the mean and variance estimates inputed in the BL model, dynamically). Secondly, we use the BL model to devise a new adaptive data-driven optimization framework to model fundamentalist as well as equilibrium information based on returns, while considering investors have different risk profiles. We present a case study based on Brazilian financial data. The results show that asset allocation instability due to estimation errors is reduced, which can provide optimal portfolios with superior-out-of-sample risk-adjusted returns.

Throughout this paper we will use bold-faced capital letters (Σ, Ω, ...) to indicate matrices, bold-faced lowercase letters (μ, r, ...) to indicate vectors and ordinary letters to indicate scalars. We assume that there is an (n × 1) vector of asset returns r. With this convention, the asset returns have a well-defined n–dimensional covariance matrix Σ; in particular, non-singular. We shall write μ ≡ E(r) to the vector of mean asset returns. This is shorthand for E(r,t|ℱt), where ℱt refers to the information set available at time t. The (n × 1) vector π represents equilibrium excess returns, either in terms of a an asset pricing model, such as the CAPM or in the

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¹ Please refer to Kim et al. (2013) and Kolm et al. (2014) for review approaches in portfolio optimization.

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sense of a market index.

We assume that the decision-maker must select a strategy before (or without) knowing the exact value taken by the uncertain parameters. Let $\mu_{BL,t}$ be the expected return for asset $i$ between time $t$ and time $t+1$ based on all the information available up to time $t-1$. In Fig. 1 we represent the time frame of the variable estimation and the model implementation.

We consider daily allocation decisions based on one-period portfolio optimization models in a rolling horizon scheme. As such, we denote by $x_t,i$ the allocation in asset $i$ made at the beginning of day $t$, considering $\mu_{BL,t}$ (a one-step ahead forecast). Afterward, we test whether this allocation was successful in an out-of-sample one-step-ahead analysis, comparing this estimated return with the observed return for time period $t+1$.

2. Investment strategy (IS-BL)

The proposed investment strategy obtains the optimal asset allocation weights by solving a MV optimization problem, considering a conditional (dynamically updated) estimate of the covariance matrix and a posterior distribution for average asset returns, obtained by the combination of estimated views and equilibrium returns. We build the views distribution $(\mathbf{P}_t, Q_t, \Omega_t)$ by emulating the decision process of fundamentalist analysts through a (PE-based) dynamic regression model and we extract equilibrium distribution $(\pi_t, \Sigma_t, \tau_t)$ from basis portfolios (for each risk profile) resulting from a target volatility system.

2.1. Time-Varying IS-BL

We model an investment strategy with conditioning information about risky assets to determine the direction and extent of asset class switching (among a risky and a riskless asset). Let $\mathbf{P}_t$ be the dynamic matrix of views, $\Omega_t$ the conditional covariance matrix of views and $q_t$ the dynamic vector of the expected excess returns for each view. To construct the CAPM implied equilibrium returns distribution we need also to define $\pi_t$ as the dynamic CAPM implied risk premiums, $\Sigma_t$ as the conditional historical covariance of returns and $\tau_t$ as the parameter to scale the conditional covariance of returns. The relation between both sources of information in given by the following extension of the original BL model

$$\begin{align*}
\mu_{BL,t} | \mathcal{F}_t &= \left[(\tau_t \Sigma_t)^{-1} + \mathbf{P}_t' \Omega_t^{-1} \mathbf{P}_t\right]^{-1} \left[(\tau_t \Sigma_t)^{-1} \pi_t + \mathbf{P}_t' \Omega_t^{-1} q_t\right] \\
\Sigma_{BL,t} &= \left[(\tau_t \Sigma_t)^{-1} + \mathbf{P}_t' \Omega_t^{-1} \mathbf{P}_t\right]^{-1} + \Sigma_t
\end{align*}$$

(1)

where $\mu_{BL,t}$ is defined on a probability space $(\mathcal{Y}, \mathcal{F}, P)$. In (1) we assume $\mu_{BL,t}$ is adapted to a filtration $\mathcal{F}_t$.

2.2. Learning model based on fundamentalist information

Practitioners and researchers alike have identified several ways to successfully predict future security returns based on historical returns and fundamentalist data (see Fabozzi et al., 2006; Cochrane, 2008). And on behalf of these predictions they make investments strategies to earn excess returns (see Piotroski, 2000; Hatta, 2012). Following several papers in the portfolio choice literature, we will consider that asset returns exhibit some sort of predictability.

Let us assume the investor must decide whether to allocate his wealth between a risky and a riskless asset. The risky asset expected returns are structured to depend on their historical returns as well as on observed realizations of fundamentalist (earnings) data; a metric which aims to predict the expected return of a stock by measuring its intrinsic value.

2.3. Market equilibrium model

We consider investors might have different risk profiles and each will have an equilibrium asset allocation, which may vary over time. For each profile we specify a conditional volatility level tolerated by the investor, which dynamically cannot be surpassed. We solve the simple MV portfolio problem of 2 assets by considering historical returns estimated based on the last 252 daily observations and portfolio volatility maintained at a pre-specified level to arrive at the portfolios $x_{rp,t}$ held by investors. Those are the basis MV

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Fig. 1. Time frame diagram.
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