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Return predictability and intertemporal asset allocation: Evidence from a bias-adjusted VAR model

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ABSTRACT

Within a VAR based intertemporal asset allocation model we explore the effects on return predictability and optimal asset allocation of adjusting VAR parameter estimates for small-sample bias. We apply a simple and easy-to-use analytical bias formula instead of bootstrap or Monte Carlo bias-adjustment. Regarding return predictability we show that bias-adjustment in the multivariate setup can yield very different results than in the univariate case. Furthermore, bias-correcting the VAR parameters has both quantitatively and qualitatively important effects on the optimal portfolio choice. For intermediate values of risk-aversion, the intertemporal hedging demand for bonds and stocks is heavily affected by the bias-correction. Utility calculations also show large effects of bias-adjustment, both in-sample and out-of-sample.

1. Introduction

One of the most fascinating results of recent research in empirical finance is that asset returns seem to contain predictable components. Until the first half of the 1980s, stock and bond returns were thought to be completely unpredictable, both at short and long horizons, and this unpredictability was taken to imply that asset markets were informationally efficient. However, since the mid 1980s researchers have become increasingly aware of the fact that stock returns are to some extent predictable from lagged valuation ratios like the dividend yield or price-earnings ratio, and that bond returns are predictable from e.g. lagged yield spreads.[1]

One area where return predictability has profound implications is asset allocation. Long-term investors can potentially benefit from return predictability, both in the form of market-timing and in the form of intertemporal hedging of future return risk. Recent research on dynamic portfolio choice under return predictability has delivered solutions for optimal asset allocations

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[1] The 'fact' that stock returns contain predictable components is not uncontroversial. Some have questioned the in-sample statistical significance of predictability (e.g. Boudoukh et al., 2008), and others have questioned whether in-sample predictability also holds out-of-sample (e.g. Welch and Goyal, 2008). Other recent studies in this area are Amihud and Hurvich (2004), Lewellen (2004), Cochrane (2005), Campbell and Yogo (2006), Ang and Bekaert (2007), Cochrane (2008), Amihud et al. (2009, 2010), Chen (2009), and Engsted and Pedersen (2010).

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using different numerical methods such as quadrature integration (e.g. Ang and Bekaert, 2002; Balduzzi and Lynch, 1999; Lynch, 2001; Lynch and Tan, 2009) and simulations (e.g. Barberis, 2000; Brandt et al., 2005; Detemple et al., 2003; Guidolin and Timmermann, 2007). Exact closed-form solutions have been obtained for models in a continuous-time setup (e.g. Kim and Omberg, 1996; Koijen et al., 2009; Munk et al., 2004; Wachter, 2002), and in discrete time a number of approximate analytical solutions have been derived (e.g. Campbell and Viceira, 1999; Campbell et al., 2003; Jurek and Viceira, 2011).

The setup in the early dynamic asset allocation models was relatively simple, often only allowing one risky asset and one state variable. This was due to, among other things, discrete-state numerical algorithms being slow and unreliable in the presence of many assets and state variables, and approximate analytical solutions requiring a very large quantity of algebra. Campbell et al. (2003) proposed a way to remedy this situation, namely by assuming that the dynamics of asset returns is well captured by a linear vector-autoregression (VAR). The idea of capturing the return dynamics in a VAR model has proven very influential in the discrete time dynamic portfolio choice literature. Using this assumption Campbell et al. are able to derive an approximate (based on Taylor expansions) analytical solution to the long-term investor's portfolio choice. Their solution is based on an infinitely-lived investor who maximizes expected discounted Epstein-Zin utility defined over consumption.[2] Campbell et al. themselves apply the methodology on US quarterly and annual stock and bond returns with the dividend-price ratio, short-term nominal yield, and yield spread as predictor variables. Rapach and Wohar (2009) use the approach on an international dataset, allowing investors to invest in both domestic and foreign assets. Both studies find evidence of substantial time-variation in optimal asset allocations as well as substantial intertemporal hedging effects coming from the predictability of asset returns. Jurek and Viceira (2011) apply the VAR based approach and derive an approximate analytical solution in a setting where the investor maximizes power utility defined over wealth at a finite horizon. Hoevenaars et al. (2008) also use the idea of capturing the return dynamics in a VAR model. They derive an analytical portfolio choice model in an asset-liability context where the finite horizon investor maximizes power utility defined over the ratio of assets to liabilities.

A potentially important drawback of the VAR based approach is that the computed optimal allocations are based on standard least squares estimates of the VAR parameters. It is well-known that such estimates are plagued with finite-sample bias that may seriously distort inference based on the VAR model, especially when the model contains variables that are highly persistent, see e.g. Bekaert et al. (1997). This will indeed be the case if predictor variables such as interest rates, dividend-price ratios and yield spreads are included in the model. These variables are typically found to be highly persistent. Campbell et al. (2003) acknowledge the finite-sample bias in their VAR estimates but state that bias corrections are complex in multivariate systems and, hence, they do not attempt to adjust for the bias.[3]

In the present paper we extend the VAR based dynamic asset allocation approach to be based on bias-corrected VAR parameters. The bias-adjustment procedure that we propose can easily be applied to all VAR based models. We invoke the analytical bias formula from Pope (1990), which holds for general VAR models under quite mild restrictions, and with properties that are comparable to standard Monte Carlo or bootstrap bias-adjustment. Pope's adjustment is straightforward to implement but, surprisingly, it has been left unnoticed in most of the empirical finance literature using VAR models. Among the few papers that have used this bias formula are Amihud and Hurvich (2004), Amihud et al. (2009), and Engsted and Tanggaard (2004, 2007). Examining return predictability, Amihud and Hurvich (2004) and Amihud et al. (2009) apply the analytical bias formula to develop a bias-adjusted predictive return regression with multiple predictors.[4] In a slightly different setting, Engsted and Tanggaard (2004, 2007) use Pope's bias-adjustment in VAR based variance decompositions for asset returns.[5]

When applying the analytical bias formula we follow the standard approach in the literature on bias-correction and simply substitute in the biased least squares estimates to get the bias-adjusted estimates. The formula holds for the true values of the VAR parameters and hence it is not obvious that this approach improves over least squares because bias-adjustment with estimated bias terms introduces additional noise. To examine if this is indeed the case we initially conduct a small simulation study to examine the properties of the bias-adjustment procedure.

In an empirical application we first focus on the VAR parameter estimates themselves in order to examine the consequences for return predictability of using multivariate bias-adjustment instead of the usual univariate adjustment. Second, we use the VAR based asset allocation model by Campbell et al. (2003) to compute optimal portfolio weights using both adjusted and unadjusted VAR estimates in order to see whether the bias-adjustment is quantitatively and qualitatively important in practice. We use the original quarterly data from Campbell et al., which extends from 1952:q1 to 1999:q4, in order to make the results comparable to theirs. Finally, based on the model setup from Jurek and Viceira (2011), we conduct an out-of-sample evaluation of realized utility in the period 2000:q1 to 2009:q4.

[2] Campbell et al. (2003) is a multivariate extension of the approximate analytical solution by Campbell and Viceira (1999) that allows for only one risky asset whose expected excess return is governed by a single state variable that follows an AR(1) process.

[3] In contrast to the analysis of multivariate systems, bias correction in *univariate* models is standard and with a huge literature, e.g. Nelson and Kim (1993), Stambaugh (1999), and Lewellen (2004) just to name a few. In most of this literature focus has been on obtaining correct test statistics for the null of no predictability rather than obtaining better bias-adjusted point estimates to be used in e.g. portfolio allocation models, as is our aim.

[4] Amihud and Hurvich (2004) and Amihud et al. (2009) refer to the analytical bias formula by Nicholls and Pope (1988), which is identical to the bias-formula by Pope (1990). Nicholls and Pope (1988) derive an expression for the least squares bias in Gaussian VAR models, while Pope (1990) basically shows that this expression also applies to a general VAR model without the restriction of Gaussian innovations.

[5] There is also a Bayesian literature on parameter uncertainty and learning in dynamic asset allocation, see e.g. Barberis (2000), Xia (2001), Hoevenaars et al. (2007), Wachter and Warusawitharana (2009), and Diris et al. (2010). In contrast to these studies, however, our analysis is non-Bayesian and instead focuses on the parameter uncertainty introduced by small-sample bias in a classical setup.