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A Bayesian view of temporary components in asset prices ☆

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Abstract

This paper studies models in which the a stock price contains a random walk and a stationary component, as in Fama and French [Fama, Eugene F., and Kenneth R. French, 1988, Permanent and Temporary Components of Stock Returns, Journal of Political Economy 96, 246–273.] and Poterba and Summers [Poterba, James, and Lawrence Summers, 1988, Mean Reversion in Stock Prices: Evidence and Implications, Journal of Financial Economics 22, 27–59.]. We extend this model to allow for two latent factors which generate short term and long term autocorrelations, respectively. To facilitate econometric identification, we assume that these factors are common across multiple asset returns, and we estimate the factor loadings. In an application to size and book/market sorted portfolios, we find the short term factor economically and statistically insignificant. Estimates of parameters relating to the long range component suggest that portfolios of small firm stock display about three times the amount of mean reversion than for large firm stocks. Overall, the evidence suggests that mean reversion is largely a small firm phenomenon. The evidence is consistent with dynamic equilibrium models in which asset prices co-integrate with aggregate consumption or dividends.

JEL classification: G12; G14; C11; C32
Keywords: Predictability; Long run reversal; Kalman filter

1. Introduction

Few topics in finance have been debated as heavily as the random walk hypothesis of security prices. There is no doubt that a large fraction of the daily or annual stock market return is unpredictable, as the random walk hypothesis would suggest. While it is understood that asset returns contain a very small predictable component at best, interest in the issue persists because even small amounts of predictability could prove valuable to asset managers.

In the debate over predictability, it is widely recognized that there exists time series such as price-multiples, interest rates and other macro variables that correlate significantly with future asset returns using standard methods of statistical inference. The results are still controversial because "standard methods of inference" do not adjust for the fact that these variables are selected out of a larger set of variables which leads to an overstated level of statistical significance ("data-snooping bias"). A second strand of the literature focuses on serial correlations. Results presented in Fama and French

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(1988) in support of the predictability hypothesis, showing seemingly significant long run autocorrelations consistent with a model in which stock prices contain a random walk, and a stationary component. This evidence is widely contested. Richardson (1993) shows that the Fama–French analysis understate the standard errors in long term autocorrelations. Also, the infamous U shaped pattern in the autocorrelation function disappears once the highly volatile 1926 to 1940 period is removed from the data set. Fama (1991) concludes that the tests based upon the autocorrelation function have low power due to the effectively small sample sizes for long horizon correlations.

The lack of power in autocorrelation based tests poses a challenge which cannot be resolved unless the econometrician is willing to impose parametric assumptions about the functional form of the autocorrelation function. This can be accomplished by assuming a particular form of the dynamic model that generates asset returns. For example, in a model in which prices and dividends are cointegrated, as is the case in many dynamic equilibrium models, stock prices follow the stationary component model studied by Fama and French (1988) and Poterba and Summers (1988). The model (henceforth the Shiller–Summers model as coined in Fama (1991)) has only four parameters which jointly describe the autocorrelation function.

A generalized version of the Shiller–Summers model is estimated in Lamoureux and Zhou (1996). Their paper studies a model in which the stationary price component follows an AR(4) process. In a Bayesian analysis of the structural model, Lamoureux and Zhou conclude that the data contain little or no evidence of a predictable component. Their analysis also reveal that the data are very uninformative about the structural parameters. Many of the autoregressive coefficients that drive the stationary price component have posterior standard deviations which are almost indistinguishable from the prior standard deviations.

In this paper we study a generalized version of the Shiller–Summers model. We generalize the model in two important ways. First, the price process has three components: A permanent (random walk) shock, a long run mean reverting component and a short term predictable component. Second, the three factor structure makes the model very hard to identify from univariate time series data. To overcome the identification problem, we propose a model structure in which asset returns are generated in a linear factor form: the returns on all assets are linear functions of a short term AR(1) process and a long range differenced AR(1) process, as well as asset specific shocks. The coefficients relating the individual asset returns to the common factors are estimated jointly with the parameters governing the dynamics of the state variables. The class of models considered here are perfectly consistent with dynamic equilibrium models in which the time-variation in which the price responds negatively to a temporary increase in risks.

The hypothesis that prices contain a permanent, random walk component and a mean reverting component is perfectly consistent with equilibrium models. In particular numerous models produce equilibrium price/dividend dynamics of the form $P_t/D_t = G(F_t)$ where G is some nonlinear function of a set of state variables, F_t. The state variables are typically related to time varying risks. For example, a model with time-varying volatility of the intertemporal marginal rate of substitution will generate this type of dynamics with F_t equal to the volatility factor. Under additional assumptions, $G()$ can be made to be exponential affine or approximately exponential affine. This is the case in Campbell and Shiller (1987, 1988), Bansal and Yaron (1997), Bansal, Dittmar, and Lundblad (2005), Eraker (2006), among others. For these models, the equilibrium log price equals the log dividend plus the stationary component F_t and thus produce equilibrium price dynamics which is of the form considered in this paper. The presence of a predictable component of asset returns is thus perfectly consistent with equilibrium pricing. In fact, if stock prices exhibit pure random walk they would not be consistent with the dynamic equilibrium models in the above referenced papers.

A summary of the results obtained in this paper are as follows. First, we fit the Shiller–Summers model to size and book sorted portfolios using univariate specification. The parameters are quite well identified using the uniform prior distribution. Using the univariate model specification, we find moderate amounts of predictability. The predictable component is not deemed statistically significant. The lack of precision in parameter estimates, and thus also the latent extracted factor, lead to a significant posterior probability mass on the possibility that returns contain essentially only a random walk component. In moving to our multivariate generalization of the Shiller–Summers model, we obtain much sharper estimates of the parameters of interest. The results show some interesting patterns. Predictability is statistically significant at the three to ten year horizon for portfolios of small firms. Large firm portfolios, on the other hand, all contain insignificant amounts of predictability. The "factor loadings" increase almost uniformly along the size dimension.

Our multivariate model specification also contain a common factor designed to capture predictable variation in returns at short horizons. Specifically, the "short term factor" is an AR(1) process that enter linearly in the return generating process. This is consistent with the equilibrium specifications in Bekaert and Harvey (1995), Brandt and