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Optimal Portfolio Investment and consumption Strategies in Indian equity market

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Abstract

A number of investment strategies map out to maximize portfolio growth are tested on a long run Indian equity market. The application of the optimal portfolio techniques produces magnificent rate of growth, In spite of the fact that the assumptions of normality. Optimal portfolios are constructed by rebalancing the portfolio weights of four indices and ten sectors of National stock exchange indices. The purpose of this paper is to examine the Optimality of the Portfolio in the NSE and examine hypothesis the application of efficient market. The sample of stocks is not large in spite of its comprehensiveness from the local stock market . This paper also analyzes optimal portfolio and consumption strategies with unobservable states and predictability of risky asset returns. We develop approximate analytical solutions to the unconstrained dynamic problem. The approximation is shown to be fast and accurate. The computation time of the approximate solution is shown to be practically independent of the number of assets when no predictors are present and only marginally affected by the number of predictors. While the portfolio policy strongly depends on the current state of the economy, the consumption-to-wealth ratio is violently state-independent. Hedging demands are negligible with regimes and no predictability, but are important with predictability. On the other hand, the consumption to wealth ratio is not very impacted by the predictor. We provide an out of sample statistical assessment of the returns provided by a multi-regime strategy with respect to a single-regime and to a 1/N strategy.

Keywords: Optimally, Portfolio ,consumption strategy

Introduction

To allocate their wealth between several asset classes over time, investors have to determine how asset returns evolve dynamically. They could assume simple processes with constant coefficients but they will be at odds with the numerous changes that affect their means, volatilities and correlations. In the global financial crisis of 2008-2009, stock returns exhibited drastic changes in their time-series characteristics. More generally, they evolve differently in the various phases of the business cycle. Since the seminal paper of Hamilton(1989), Markov-switching models have been widely used to capture these sudden changes in financial markets . Investors face a challenge since these regimes are not observable with certainty and they need to infer their probabilities of occurrence and their duration based on observed-returns and possibly some predictive variables. Moreover, they need to use time-consuming numerical techniques to build optimal dynamic portfolios. In this paper we provide approximate analytical solutions to these complex portfolio allocation problems. Our method is fast and accurate compared to numerical solutions. Adding assets does not change computation time while adding predictors only affects it marginally.

Therefore, our method offers practical solutions to portfolio managers that have to rebalance sizable portfolios frequently.

Procedure

We assume that investors solve a general finite-horizon portfolio allocation problem with consumption, in which we distinguish risk aversion and intertemporal substitutability with a stochastic differential utility. We allow for the presence of a predictor variable pt in a multi-regime economy.
The regimes are hidden, and investors have to estimate the probability π of each state at each point in time. Our general solution admits a wealth-separable solution of the form:
V (Wt, Pt, πt,T) = H (Pt, πt, T)t ,in which Wt represents the investor's wealth at time t and ţ
ţ = T - t is the time remaining till the final horizon T. We find an approximate linear expression for H (pt, πt, ţ) in terms of the state variables pt, Pt, πt and their squares. The coefficients multiplying the state variables are horizon-dependent and solve a system of ordinary differential equations.
The optimal portfolio strategy contains the usual myopic allocation and two hedging demands related to the predictor and to the regime probabilities, all inversely proportional to the coefficient of risk aversion. The three components depend also implicitly on the elasticity of intertemporal substitution (EIS). Optimal consumption is affected by the state variables through the function H (Pt, πt,ţ) and is directly impacted by the EIS.
To assess the accuracy of our solution method, we use a model similar to Guidolin and Timmermann (2007), with four regimes in the returns of large and small stocks and bonds. Wevcompare our approximate solution to their optimal numerical solution based on Monte Carlo methods. We show that the approximate portfolio shares are very close to the optimal ones when regimes are assumed to be known or when the investor needs to estimate the probabilities of being in each of the states. We also measure the wealth equivalent utility loss created by using the approximate solution instead of the optimal solution obtained by simulation and conclude that it is negligible .
To evaluate the economic importance of considering multiple regimes we conduct an out-of-sample exercise to compare the returns of a portfolio allocation to large stocks, small stocks, bonds and a risk-free asset for a four-regime model, a single-regime model and a 1/N strategy. We assume an investment horizon of 10 years with a monthly rebalancing of the portfolio. We compute the differences in annualized certainty equivalent returns between the four-regime portfolio and the two benchmark portfolios and their bootstrap confidence intervals. When stock and bond returns are predictable by the dividend yield, we observe that the share invested in large stocks increases in the short run with respect to the case without predictability but mean reversion in the predictor makes it go down after 3 to 4 years up to the 10-year horizon. Small stocks pick up some of the slack left by large stocks but the overall share in stocks still exhibits a mean-reverting pattern. The presence of hedging demands with respect to the predictor increases the expected loss suffered by a myopic investor at long horizons. This contrasts with negligible hedging demands in the absence of a predictor. Accounting for intermediate consumption in the investor's problem, we conclude that the consumption-to-wealth ratio does not vary much with the predictor and with the regimes.
Several papers have studied dynamic optimal portfolio problems under regime-switching processes in discrete time when regimes are unobservable. Angand Bekaert(2002) solved
numerically a two-regime portfolio problem with international assets, while Guidolinand Timmermann(2007) use Monte Carlo techniques to solve an allocation between large and small stocks

and bonds in a four-state regime switching model. In continuous time, Liu(2011) examines consumption-portfolio problem in which the
expected return of a single risky asset follows a hidden Markov chain, under ambiguity. The investor's optimal choices are not in closed-form, but characterized in terms of Malliavin derivatives and stochastic integrals. This model nests the expected utility model of Honda(2003). Many papers analyze the problem of dynamic portfolio allocation with fully observable regimes. Yinand Zhou (2003) find an explicit solution when an investor minimizes the variance of a given fixed expected terminal wealth and does not consume.

Sotomayorand Cadenillas (2009) study the consumption-portfolio problem of a power utility investor who maximizes the expected total discounted utility of consumption and find optimal exact portfolio and consumption policies. All market parameters (interest rate, stock drift and volatility) are constant within a regime. They work under infinite horizon and hence are not able to capture and analyze horizon effects. Limand Watewai(2012) consider the problem of optimal asset allocation for a regime-switching model with jumps. They find semi-explicit expressions for the optimal policy in terms of the solution of a system of ordinary differential equations with CRRA utility. Çanakoğluand Özekici (2012) also find explicit solutions for optimal portfolio policy for HARA utilities in terms of solutions of ordinary differential equations. Lópezand Serrano(2015) find closed-form expressions of the optimal value function in a pure-jump model for agents with log-utility and fractional power utility in the case of two-state Markov chains. Xing solve optimal portfolio and consumption problems with Epstein-Zin recursive utility without regime switching. Several other papers are related to our work.

Graflund and Nilsson(2003) study the relevance of intertemporal hedging and regimes under a dynamic portfolio problem with no consumption in which the investor maximizes power utility from terminal wealth. The discrete-time setting includes one risky asset and a riskless bond, in which the investor rebalances the portfolio monthly. The problem is again solved numerically, conditional on the current observable regime, with the number of regimes being determined with a Monte Carlo likelihood ratio test. They conclude that ignoring the regimes for long-horizon investors is costly, while intertemporal hedging is present in some regimes but not in others. The importance of regime shifts for modeling asset returns has been examined by a number of researchers. For example, Angand Bekaert(2004) show the importance of regime switching models in tactical asset allocation. Similarly, Tu(2010) concludes that certainty-equivalent losses associated with ignoring regime switching in portfolio decisions are generally above 2% per year.

Guidolinand Hyde (2012) show that vector autoregressive models cannot capture regime shifts in asset returns. They use a three-regime model in which the investor has power utility. All these papers are set in discrete-time and solve the problem numerically, via Monte Carlo methods. Guidolin, Timmermann, 2006, Guidolin, Timmermann, 2008 use a discrete-time regime switching model for asset returns to solve the portfolio problem (with no consumption), in which the investor has utility over moments of the terminal wealth distribution. The current regime is observable and the approximate optimal portfolio weights are found as the roots of a system of polynomial equations (first-order conditions). Under unobservable regimes, Guidolin, Timmermann, 2005, Guidolin, Timmermann, 2007 specify a four-state regime switching model in discrete-time with a richer risky asset menu (one large-stock index, one small-stock index and a ten-years bond). Their optimal choices, under power time-additive utility, are found numerically, with Monte Carlo techniques. Using the same techniques, Guidolin and Timmermann (2008) consider an allocation over size and value consider an allocation over size and value portfolios.

The rest of the paper is structured as follows. Sections 2 and 3 describe the economy and the investor's problems respectively. The solution and its approximation are explained in Section4. In Section5, we compute optimal portfolios in a four-
regime model with four assets by numerical methods and assess the accuracy of our a approximate solution. We also conduct an out-of-sample exercise and introduce a predictor to show how it affects optimal strategies. The case with intermediate consumption is discussed. Section6 analyzes the impact of adding assets or predictors on the computation time. We conclude in Section 7. An appendix provides all the necessary details about the approximate Bellman equations and the Monte Carlo simulation procedures to assess the accuracy of the approximate solution.

Conclusion

This paper derives an approximate analytical solution to a dynamic portfolio and consumption problem under stochastic differential utility in a multi-regime economy. We have shown that the method is accurate in a comparison with a numerical solution of the four-asset, four-regime model of Guidolinand Timmermann (2007), which features a portfolio allocation between large and small stocks, long-term government bonds and a risk-free asset. The main advantage of the method is its speed of...

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