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Evaluating time-series restrictions for cross-sections of expected returns: Multifactor CCAPMs

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ABSTRACT

A number of recent papers have developed multifactor extensions of the classic consumption capital asset pricing model (CCAPM) and generally concluded that conditioning information improves the empirical performance. This paper asks whether the superior empirical performance of the multifactor CCAPMs is maintained once the time-series intercept restrictions are explicitly tested. The maximum correlation portfolio (MCP) approach is employed to implement the intercept restrictions. The empirical findings support the conclusion that multifactor CCAPMs can explain the cross-section of expected stock returns better than classic unconditional models. Moreover, several of the multifactor CCAPMs are shown to perform as well as or better than the Fama–French three-factor model.

1. Introduction

A number of recent papers have developed multifactor extensions of the classic consumption capital asset pricing model (CCAPM), to find that they perform remarkably well in explaining the cross-section of stock returns (e.g., Lettau and Ludvigson, 2001b; Lustig and Van Nieuwerburgh, 2005; Santos and Veronesi, 2006; Piazzesi et al., 2007). Multifactor models can be considered conditional versions of the standard CCAPM because the weights in the linear factor representations of these models are not fixed, but rather modeled as functions of information known at time *t*. Such consumption-based models have factors that are not returns, and have been tested using cross-sectional regressions.

For models in which factors are returns, the single testable implication is that intercepts from time-series regressions of test asset returns on the factors should be jointly zero. In models where factors are not returns, such time-series intercepts are not unrestricted, but they involve unknown parameters that must be estimated, which complicates testing as to whether the intercept restrictions hold. However, a complete assessment of the success of prominent multifactor extensions requires an evaluation of whether the time-series intercept

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restrictions are in fact satisfied. Breeden et al. (1989) and MacKinlay and Richardson (1991) are examples of early studies discussing tests of the intercept restrictions. Lewellen and Nagel (2006) point out that recent studies on the multifactor CCAPMs evaluate the importance of conditioning in asset-pricing tests only based on cross-sectional regressions, without imposing time-series intercept restrictions.

One way to test whether the time-series intercept restrictions of multifactor CCAPMs are satisfied is to use maximum correlation portfolios (MCPs), as proposed by Breeden (1979), Grinblatt and Titman (1987), Huberman et al. (1987), Breeden et al. (1989), Lamont (2001), and Balduzzi and Robotti (2008). By employing MCP returns that are maximally correlated with the original factors, tests of the models once again collapse to evaluating the single implication that the time-series intercepts must be jointly zero. Breeden et al. evaluate the standard CCAPM with consumption growth as a single factor, and show that the CCAPM holds with respect to a set of test assets when betas are measured relative to a portfolio that has maximum correlation with the consumption growth. Balduzzi and Robotti consider an MCP-based formulation of linear factor models with nontraded factors as an alternative to the standard formulation that is estimated by cross-sectional regressions, and study the small-sample properties of estimates and test statistics.

This paper tests specific multifactor CCAPMs that have been found previously to explain the cross-section of expected stock returns better than the standard unconditional CCAPM. The principal question is as to whether the superior cross-sectional performance of such models is maintained once time-series intercept restrictions are explicitly recognized. The candidate models include the scaled CCAPM proposed by Lettau and Ludvigson (2001b), in which the consumption–wealth ratio is used as a conditioning variable; the consumption–housing CAPM of Piazzesi et al. (2007), in which the non-housing consumption expenditure share is used as a conditioning variable; the collateral-CCAPM of Lustig and Van Nieuwerburgh (2005), in which the housing collateral ratio is used as a conditioning variable; and the conditional CCAPM with the labor income of Santos and Veronesi (2006). For comparison, we also test the standard CAPM and the Fama–French three-factor model (Fama and French, 1993), the leading empirical model for explaining cross-sectional variation in average stock returns.

We report two main results. First, time-series intercept-based tests show that the multifactor CCAPMs explain the cross-section of stock returns better than classic unconditional models, such as the CAPM and CCAPM. Second, some of the multifactor CCAPMs are shown to perform as well as, and sometimes better than, the Fama–French three-factor model. Prior studies (cited above) indicate that the multifactor extensions of the CCAPM perform about as well as the Fama–French model when evaluated according to cross-sectional regressions. This paper adds to existing literature by testing the multifactor CCAPMs with the time-series intercept restrictions and demonstrating that several of the multifactor CCAPMs match or surpass the Fama–French model even when the intercept restrictions are explicitly imposed.

The rest of this paper is organized as follows. Section 2 explains the specifications of unconditional and multifactor CCAPMs. Section 3 presents the restrictions on the intercepts in time-series regressions, which provide the basis for the cross-sectional asset pricing test. The methodology for testing the time-series restrictions using MCPs in place of original factors is also addressed in this section. Section 4 describes the specific multifactor CCAPMs that are considered in this paper and discusses which variables are used as factors in those models. Section 5 describes the data and presents the empirical results. In doing so, we first compare the pricing errors across the candidate models, and then conduct the statistical tests as proposed by Gibbons et al. (1989), as well as alternative bootstrap tests, to evaluate the cross-sectional performance of the models with the time-series intercept restrictions explicitly imposed. Section 6 presents the paper's conclusions.

2. Unconditional versus scaled multifactor CCAPMs

This section begins by motivating the general form of a multifactor extension of the classic CCAPM. This paper assumes throughout that the risk-free rate R_t^f is observed. Let M_{t+1} be the stochastic discount factor. Any tradable asset with return R_{t+1} must satisfy

$$1 = E_t\left[M_{t+1}R_{t+1}\right], \tag{1}$$

where E_t denotes the expectation conditional on the information known at time t. For the basic consumption-based model, the asset pricing Eq. (1) is derived from the first-order condition for the optimal consumption choice of a representative agent, and M_{t+1} is equal to the intertemporal marginal rate of