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Habit persistence: Explaining cross-sectional variation in returns and time-varying expected returns ☆

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ABSTRACT

This paper uses an iterated GMM approach to estimate and test the consumption based habit persistence model of Campbell and Cochrane [Campbell, J.Y., Cochrane, J.H., 1999. By force of habit: A consumption-based explanation of aggregate stock market behavior. Journal of Political Economy 107, 205–251] on the US stock market. The empirical evidence shows that the model is able to explain the size premium, but fails to explain the value premium. Further, the state variable of the model – the surplus consumption ratio – explains counter-cyclical time-varying expected returns on stocks. The model also produces plausible low real risk-free rates despite high relative risk aversion.

1. Introduction

Within the consumption based asset pricing framework, the habit persistence model of Campbell and Cochrane (1999) has become one of the leading models in explaining asset pricing behavior. The Campbell–Cochrane model explains a number of stylized facts on the US stock market, including pro-cyclical stock prices, time-varying counter-cyclical expected returns, and it has the ability to explain the equity premium puzzle without facing a risk-free rate puzzle. Campbell and Cochrane and most subsequent applications of their model rely on calibration and simulation exercises and do not engage in formal econometric estimation and testing of the model. They calibrate the structural parameters of the model to match historical means of the risk-free rate and the Sharpe ratio, and then simulate a chosen set of moments which are informally compared to those based on the actual historical data.

Instead of calibrating and simulating the Campbell–Cochrane model, this paper uses an iterated GMM approach to estimate and test the model on the US stock market over the period 1947–2005. The model is estimated in a cross-sectional setting using the 25 Fama and French value and size portfolios, which has not been tried previously, see Cochrane (2007). Following the suggestion of Lewellen et al. (forthcoming), I expand the portfolio set beyond the value and size dimensions by including 10 industry portfolios. The estimation of the model reveals that it has difficulties in explaining the value premium, but provides a great fit of the size premium. The inability of the model to explain the value premium relates to recent work by Lettau and Wachter (2007) and Santos and Veronesi (2008). They

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argue that due to the negative correlation between changes in consumption and the price of risk, the Campbell–Cochrane model is likely to generate a growth premium instead of a value premium.

Besides cross-sectional variation in stock returns, the paper examines whether the model captures time-variation in expected stock returns. The model has the intuitively appealing implication that expected stock returns vary counter-cyclically over the business cycle. As a result, investors require a higher expected stock return in recession times when consumption is close to habit. The empirical evidence shows that the surplus consumption ratio is significantly negatively related to future excess stock returns, implying that low surplus consumption – when consumption gets close to habit in recession times – predicts high future excess stock returns. These findings are consistent with Li (2001, 2005) who uses Campbell and Cochrane's calibrated parameter values to examine the predictive power of the surplus consumption ratio.

Following the suggested extension in Wachter (2006), the paper allows for a time-varying real risk-free rate in order to generate cyclical variation in interest rates and a nontrivial term structure. Despite high relative risk aversion, the model implies plausible low values for the real risk-free rate, i.e. the model explains the equity premium puzzle without facing a risk-free rate puzzle. However, the estimated structural parameters of the model imply counterfactual implications for the slope of the yield curve.

Only a few papers engage in formal econometric estimation of the Campbell–Cochrane model. Fillat and Garduño (2005), Garcia et al. (2005), and Tallarini and Zhang (2005) estimate the model on US data.[2] However, they all consider the baseline version of the model with a constant real risk-free rate and only use a small cross section of equities. This paper differs by allowing for time-variation in the real risk-free rate and by testing whether the model accounts for the cross-sectional variation in returns on value, size and industry portfolios, as well as variation of expected returns over time.[3]

The paper relates to Bekaert et al. (2005), Buraschi and Jiltsov (2007), and Wachter (2006) who explore extensions of the Campbell–Cochrane model to explain the full term structure of interest rates. Moreover, Verdelhan (forthcoming) extends the Campbell–Cochrane model to explain the foreign exchange risk premium. Bekaert et al. (2009) consider time-varying counter-cyclical risk aversion as well as economic uncertainty as sources of risk and find that both are important in explaining many asset pricing phenomena.

The paper also relates to the growing body of literature documenting time-varying expected stock returns, see Cochrane (2007) for a recent survey. Fama and French (1989) link financial forecasting variables to the business cycle and suggest that investors require a higher expected return at a business cycle trough than they do at a business cycle peak. The surplus consumption ratio in the Campbell–Cochrane model is a pure macroeconomic variable that provides a direct link between expected stock returns and the business cycle.

The paper is organized as follows. Section 2 introduces the Campbell–Cochrane model, Section 3 describes the empirical methodology, Section 4 describes the data, Section 5 reports the empirical results, and Section 6 concludes.

2. The Campbell–Cochrane model

Following Campbell and Cochrane (1999), the utility function of the representative investor is:

$$E\sum_{t=0}^{\infty}\delta^t\frac{(C_t-X_t)^{1-\gamma}-1}{1-\gamma}, \tag{1}$$

where δ is the impatience parameter, γ is the utility curvature parameter, C_t is consumption, and X_t is an external habit level. Campbell and Cochrane define the surplus consumption ratio S_t by:

$$S_t\equiv\frac{C_t-X_t}{C_t}, \tag{2}$$

and specify the log of the surplus consumption ratio $s_t=\log(S_t)$ as a stationary first-order autoregressive process:

$$s_{t+1}=(1-\phi)\bar{s}+\phi s_t+\lambda(s_t)v_{t+1}. \tag{3}$$

Here ϕ is the habit persistence parameter, $\bar{s}$ is the steady state level of s_t, and $\lambda(s_t)$ is a sensitivity function that determines how innovations in consumption growth v_{t+1} influence s_{t+1}. The model assumes that log consumption $c_t=\log(C_t)$ follows a random walk:

$$\triangle c_{t+1}=g+v_{t+1},\quad v_{t+1}\sim niid\left(0,\sigma_c^2\right), \tag{4}$$

where g and σ_c are the mean and volatility of the log consumption growth rate. The sensitivity function $\lambda(s_t)$ is specified as follows:

$$\lambda(s_t)=\left\{\begin{array}{ll}\frac{1}{\bar{S}}\sqrt{1-2(s_t-\bar{s})}-1, & s_t\le s_{max}\\ 0 & s_t\ge s_{max}\end{array}\right\}, \tag{5}$$

where

$$\bar{S}=\sigma_c\sqrt{\frac{\gamma}{1-\phi-B/\gamma}},\quad s_{max}=\bar{s}+\frac{1}{2}\left(1-\bar{S}^2\right),\quad \bar{s}=log\left(\bar{S}\right).$$

[2] Engsted and Møller (forthcoming) estimate the model outside the US and find that it does not perform better than the simple CRRA model in explaining Danish asset returns.

[3] Chen and Ludvigson (forthcoming) also estimate a habit-based model on the 25 Fama and French portfolios, but they treat the functional form of the habit as unknown.