

Predictability of Stock Returns and Consumption-based CAPM: Evidence from a Small Open Market

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Abstract

In this study, we use the conditional consumption CAPM (CCAPM) with the consumption-wealth ratio and/or the surplus consumption ratio to examine the predictability of returns in the Australian equity market. We also explore the relationship between expected excess market returns in Australia and the time-varying risk aversion associated with the world as well as local consumption. Our study reveals that the consumption-wealth ratio can predict the variation of excess stock market returns at the intermediate horizons (from 1 year to 2 years); on the other hand, the surplus consumption ratio can only predict excess stock market returns at the very short horizon, one quarter ahead. We show that these two state variables are not mutually exclusive, but complementary. As a small but open market, Australian market's expected returns should be affected by global price of consumption risk. Our results show that both the world surplus consumption ratio and the world consumption-wealth ratio have predictive power for excess returns in the Australian equity market over the long horizons.

Keywords: Consumption-based CAPM, Consumption-wealth Ratio, Habit Formation, Asset Pricing

JEL Classification Codes: G12; G15

1. Introduction

Starting from Rubinstein (1976), Lucas (1978) and Breeden (1979), many authors define equilibrium in the capital markets using consumption variables. Under a number of assumptions, the asset returns should be linearly related to the growth rate in aggregate consumption as long as the parameter of the linear relationship remaining constant over time. Despite the theoretical soundness and simplicity, the consumption-based asset pricing model (CCAPM) is usually not easy to be explicitly estimated for the highly non-linear nature and non-separability of consumption utility among periods. GMM, initiated by Hansen and Singleton (1982), is a good tool for solving CCAPM empirical problems. However, estimates from GMM always depend on the choice of instrumental variables. With different sets of instruments, the estimated results may differ significantly. The well-known weak identification problem may also plague the reliability of results (Stock and Wright 2000). When coming back to canonical Consumption CAPM models, it has not performed well empirically (e.g. Mankiw and

Shapiro 1986; Breeden, Gibbons and Litzenberger 1989), and they are rejected both on the U.S. data (Hansen and Singleton 1982) and international data (Wheatley 1988).

In response to this, some authors have modified the consumption-based CAPM hoping to enhance the empirical performance of the model. Campbell and Cochrane (1999) introduce a habit formation variable – surplus consumption variable, which is the time-varying consumption in surplus to habit, to modify the optimal choices of consumption over time to explain the cyclical variation in expected returns and volatility. The habit formation of Campbell and Cochrane (1999) is non-linear, slow-moving and external in response to the history of consumption. They find that due to the fact that risk aversion is inversely related to surplus consumption, a high level of consumption exceeding habit should forecast low expected stock market returns. Their model is infinite-horizon non-linear model. In light of this, Li (2001) argues that the finite-horizon linear habit model also indicates the inverse relation between expected returns and surplus consumption, and it performs almost as well as Campbell and Cochrane's (1999) nonlinear habit model for the U.S. market.

The modified consumption-based asset pricing model can not only explain U.S. stock market returns, but also predict the international stock market returns. Using quarterly data of 17 national indices from Morgan Stanley Capital International (MSCI), Li and Zhong (2005) investigate the predictability and the cross-section of returns from international equity markets under consumption-based asset pricing model with habit formation. Their findings suggest that the domestic and world's log surplus consumption ratios, scr_t , partly explains the returns from most of the developed equity markets. Their cross-sectional tests of CCAPM under habit formation show that the model performs slightly better than the unconditional world CCAPM and CAPM, the conditional world CAPM and a three-factor international model.

Li, Lu and Zhong (2004) investigate the predictability of stock returns from industry portfolios of the U.S. market using aggregate consumption in surplus of habit. They find that a considerable large amount of predictability of long-horizon industry portfolio returns are explained by the surplus consumption ratio and the time varying betas and time-varying market risk premium associated with the surplus consumption ratio help explain the predictability of long-horizon expected returns over half of the U.S. industry portfolios.

In a recent paper, Jacobs and Wang (2004) examine the significance of idiosyncratic consumption risk for the cross-sectional variation in asset returns. They find that the cross-sectional variance of consumption growth and the rate of aggregate consumption growth are both significant pricing factors for asset returns. The results suggest that this two-factor CCAPM outperforms the CAPM and perform almost as well as the Fama-French three-factor model.

Furthermore, the recent studies by Lettau and Ludvigson (2001a, 2001b) explain time series and cross-sectional variation of US portfolios returns with a log consumption-wealth ratio called \widehat{cay}_t , which is constructed as the residual from the shared trend among log consumption (c_t), log asset holding (a_t) and log labor income (y_t). Under the assumption of a representative agent's binding intertemporal budget constraints, they find there is cointegration relationship between log consumption, log asset holding and log labor income, and their constructed log consumption-wealth ratio (\widehat{cay}_t) can predict U.S. stock market excess returns at short and intermediate horizons. Moreover, \widehat{cay}_t can serve as the state variable of CCAPM to explain cross-sectional stock market returns and its performance can be compared to the Fama-French three-factor model. \widehat{cay}_t can help forecast about 9% of one quarter ahead excess market returns and explain about 70% of the cross-sectional returns in U.S. data with the framework of Breeden's (1979) CCAPM and Jagannathan and Wang's (1996) Human Capital CAPM. The performance of \widehat{cay}_t is also evidenced in U.K. and Japanese markets (Gao and Huang 2004).

There are three reasons for us to choose Australian equity market as a case study of return predictability based on the consumption-based CAPM. First, international evidence of returns

predictability based on \widehat{cay}_t and scr_t in countries other than the U.S. is limited, partly because of the unavailability of reasonably good data. These data from Australia, however, are available to the authors. Second, few studies examine the predictability of stock returns based on both state variables, scr_t and \widehat{cay}_t . We argue in Section 2 that these two state variables are theoretically not mutually exclusive but complimentary in explaining asset returns. Third, in light of the incomplete market risk sharing argument (Li and Zhong 2005), asset returns may be better explained by both domestic and international prices of risks. The choice of the country should take into consideration of its openness to the global markets. Australia is a small but open market and is deemed an ideal case for our study.

In this paper, we fill the gap of the literature and provide an empirical investigation of the predictability and variation of excess returns in the Australian equity market using two consumption state variables: the log surplus consumption ratio, scr_t , and the log consumption-wealth ratio, \widehat{cay}_t . Under the assumption that consumption and dividends follow random walk processes in the habit-based model, the market risk premium should vary with a single state variable: the surplus consumption ratio. We use OLS regressions to examine the predictability of these two state variables for quarterly and long-horizon returns in the case of Australia. Given the recent empirical evidence on the importance of habit formation and incomplete risk sharing in the international markets, we also explore the relationship between expected excess returns in the Australian market and the time-varying prices of risks associated with the world as well as local surplus consumption.

Our empirical results provide international evidence of reasonable predictive power of Campbell and Cochrane's (1999) surplus consumption ratio and Lettau and Ludvigson's (2001a) consumption-wealth ratio. Moreover, our study adds a few new insights about the predictability of aggregate stock returns in the Australian equity market. We show that the consumption-wealth ratio can predict the variation of excess stock market returns at the intermediate horizons (from 1 year to 2 years); on the other hand, the surplus consumption ratio scr_t can only predict excess stock returns at the very short horizon, one quarter ahead. Including both surplus consumption ratio and consumption-wealth ratio into the regression yields higher adjusted R^2 , which suggests that these two consumption variables are not mutually exclusive, but complementary. We provide the theoretical justification in the context of including both state variables of CCAPM.

In addition to the empirical analysis of time-varying expected returns in the domestic setting, our exploratory investigation of CCAPM under incomplete integrated market reveals that Australian asset pricing are determined by both the domestic and world's prices of consumption risk. Both the world surplus consumption ratio and the world consumption-wealth ratio, apart from their domestic counterparts, have predictive power of excess returns in the Australian equity market over long horizons. Overall, the international version of CCAPM has more explanatory power than the domestic version of CCAPM. These findings suggest that when estimating Australian cost of equity using CCAPM over the usual annual horizon, one would need to use \widehat{cay}_t as a scaling factor for a domestic version of CCAPM.

The rest of the paper is organized as follows: Section 2 presents the theoretical development of the surplus consumption ratio (scr_t), the consumption-wealth ratio (\widehat{cay}_t) and the corresponding econometric models for testing. Section 3 offers a description of the data and its stochastic properties. It also contains a comprehensive discussion about how several key variables are constructed. Section 4 gives the empirical findings and relevant discussion. Section 5 concludes this paper.

2. Model Development

This section first presents the theoretical development of the surplus consumption ratio (scr_t) and the aggregate consumption-wealth ratio (\widehat{cay}_t) in the context of CCAPM. Then we derive the

corresponding econometric models using these two state variables under the hypothesis of completely segmented market. We also extend the econometric models to the assumption of the partially integrated market.

2.1. Surplus Consumption Ratio

Campbell and Cochrane (1999) present CCAPM with external habit formation where a representative agent derives utility from the difference between consumption and a time-varying habit level, and the model can capture much of excess stock returns in the long horizon. We provide a concise introduction of this model.

Assume a representative agent take the utility function as

$$E_t \sum_{j=0}^{\infty} \delta^j \frac{(C_{t+j} - X_{t+j})^{1-\gamma} - 1}{1-\gamma}, \quad (1)$$

where C_t is the per capita real consumption, X_t is the habit level, δ is the subjective discount factor, and γ is the utility curvature parameter. Abel (1990) and Campbell and Cochrane (1999) suggest the level of habit X_t to be external. X_t is also assumed to depend upon a long history of aggregate consumption and follows an infinite-horizon nonlinear formation process (Campbell and Cochrane 1999). The surplus consumption ratio SCR_t , is defined by

$$SCR_t \equiv \frac{C_t - X_t}{C_t} < 1. \quad (2)$$

SCR_t indicates the state of the economy. When SCR_t declines, consumption C_t drops to the habit level X_t , and the economy is reaching recession and investor risk aversion rises. On the other side, rising SCR_t means that current consumption exceeds X_t , and the economy is expanding, and investor risk aversion decreases.

Hereafter, we use uppercase letters to denote variables at their original scale, and lowercase letters to denote the logs of the corresponding uppercase letters. Campbell and Cochrane (1999) suggest a heteroscedastic AR(1) process for the log surplus consumption ratio, $scr_t \equiv \log(SCR_t)$:

$$scr_{t+1} = (1-\varphi)\overline{scr} + \varphi scr_t + \lambda(scr_t)\varepsilon_{c,t+1}, \quad (3)$$

where φ is the habit persistent parameter, and $\lambda(scr_t)$ is the sensitivity function, and $\varepsilon_{c,t+1}$ is the innovation in consumption growth. Campbell and Cochrane (1999) suggest that we should use a large value of the persistence parameter in order to obtain the predictive power of the log surplus consumption ratio. As in Li and Zhong (2005), we use $\varphi = 0.90$ in this paper¹. $\lambda(scr_t)$ represents the conditional sensitivity of SCR_t to C_t , and it is inversely related to the surplus consumption ratio SCR_t . When SCR_t falls, the sensitivity function $\lambda(scr_t)$ and expected excess returns rise. Consumption growth is assumed independently and identically distributed (i.i.d.).

Imposing three conditions that the risk-free rate is fixed, habit is predetermined at the steady state, and habit moves non-negatively with contemporaneous consumption elsewhere, we can specify the sensitivity function

$$\lambda(scr_t) = \max\{0, (1/\overline{SCR})\sqrt{1-2(scr_t - \overline{scr})} - 1\}, \quad (4)$$

where the steady state is $\overline{SCR} = \sigma_c \sqrt{\gamma/(1-\varphi)}$, and σ_c is the standard deviation of the unexpected consumption growth $\varepsilon_{c,t+1}$. The resulting sensitivity function $\lambda(scr_t)$ is inversely related to the log surplus consumption ratio, scr_t . Following Campbell and Cochrane (1999) and Li, Lu and Zhong (2005), we choose curvature parameter $\gamma = 2$ to compute the steady-state value of scr_t .

¹ Alternative habit persistence values ($\varphi = 0.80, 0.95$) do not alter any of the conclusions reached in this study.

Under the external habit formation, Eq. (1) implies the intertemporal marginal rate of substitution of the representative investor at time $t+1$ is

$$M_{t+1} = \left(\frac{C_{t+1} S_{t+1}}{C_t S_t} \right). \quad (5)$$

Let $R_{i,t+1}$ denote one plus the rate of return on asset i from time t to $t+1$, then $R_{i,t+1}$ satisfies the Euler equation of the following form:

$$E_t[M_{t+1} R_{i,t+1}] = 1, \quad (6)$$

where E_t is the expectation conditional on the information set as of time t .

Under the assumption of the jointly lognormally distribution of asset returns and consumption growth, the Euler equation (6) implies that expected excess returns on any asset is

$$E_t[r_{i,t+1}^e] = -\frac{1}{2} \sigma_{it}^2 + \gamma [1 + \lambda(scr_t)] \text{cov}_t(r_{i,t+1}, \Delta c_{t+1})^2. \quad (7)$$

In Eq. (7), $\frac{1}{2} \sigma_{it}^2$ is the Jensen's alpha, and the risk premiums on asset i are the price of risk, $\gamma [1 + \lambda(scr_t)]$, times the conditional covariance of the asset's returns with consumption growth. The price of risk depends on the utility curvature parameter γ and the sensitivity function $\lambda(scr_t)$. Given that the expected excess returns are inversely related to scr_t , $\lambda(scr_t)$ is inversely related to the surplus consumption ratio, scr_t (Eq. (4)). Thus investors require higher expected returns on assets when consumption falls toward habit.

Under the assumption that the conditional covariance of returns with consumption growth is constant, linear approximations to the sensitivity functions $\lambda(scr_t)$ imply that the expected excess return on asset i can be written as

$$E_t[r_{i,t+1}^e] = \alpha + \alpha_1 z_t + \beta_1 scr_t, \quad (8)$$

where z_t is a vector of information variables, scr_t is the log surplus consumption ratio and the slope coefficient β_1 is constant. Sensitivity function $\lambda(scr_t)$, according to Eq.(7), is positively related to the expected excess market returns, and scr_t is inversely related to $\lambda(scr_t)$, so the coefficient β_1 is expected to be negative. Several information variables are included in the predictability tests as motivated by previous studies [e.g. Ferson and Harvey (1998), Lettau and Ludvigson (2001a), and Li and Zhong (2005)]. These information variables are dividend yield, dividend payout ratio, detrended short term government bond returns, government bond term spread.

The model for expected one-period returns in Eq. (8) can be easily extended to a model for expected returns over multiple periods. Let $\sum_{k=1}^K r_{i,t+k}^e = r_{i,t+1}^e + r_{i,t+2}^e + \dots + r_{i,t+k}^e$ denote the cumulative excess stock market returns with continuous compounding over K periods. If scr_t are highly persistent, they should be able to predict multi-period returns. We write expected K -period excess returns as

$$E_t \left[\sum_{k=1}^K r_{i,t+k}^e \right] = \alpha^K + \alpha_1^K z_t + \beta_1^K scr_t, \quad (9)$$

where α_1^K is a vector of constants and β_1^K are constant slope coefficients³.

² See Li (2001) for detailed derivation.

³ Similar to Campbell et al. (1997), if scr_t follows an AR(1) process with an autocorrelation coefficients θ , then the law of iterated expectations implies $\beta_1^K = \beta_1 (1 - \theta^K) / (1 - \theta)$.

Assuming the growth rates of consumption and dividends are i.i.d., expected excess stock returns are determined by a single state variable – the surplus consumption ratio. Campbell and Cochrane (1999) and Li (2001) show that expected excess returns should be negatively related to the state variable because high (low) surplus consumption at the business cycle troughs (peaks) are associated low (high) investor risk aversion, thus reducing (increasing) the required rate of returns.

2.2. Consumption-Wealth Ratio

Here we theoretically derive the aggregate consumption-wealth ratio \widehat{cay}_t that provides useful conditioning information for asset returns. Consider a representative investor who invests his wealth in a single asset with a time-varying risky return R_t ⁴. We denote W_t as aggregate wealth including human capital and household asset holding at time t , C_t as consumption and R_{t+1} is the net return on the market portfolio of all invested wealth. For a complete-market model where wealth includes human capital as well as financial assets, under the intertemporal budget constraint, the period-to-period aggregate wealth is

$$W_{t+1} = (1 + R_{t+1})(W_t - C_t). \quad (10)$$

Campbell and Mankiw (1989) derive the log consumption ratio from Eq. (10). In order to make the budget constraint function linear, we approximate it by taking first order Taylor expansion (see Campbell and Mankiw (1989) for details), resulting in

$$\Delta w_{t+1} = w_{t+1} - w_t \approx k + r_{t+1} + (1 - 1/\rho)(c_t - w_t), \quad (11)$$

where the parameter ρ is the average ratio of invested wealth, $W-C$, to total wealth, W , and k is a constant.

The wealth growth rate Δw_{t+1} can be arranged in terms of consumption growth rate and the change of log consumption-wealth ratio. Solving it forward recursively, we can get a log-linear version of the infinite-horizon budget constraint

$$c_t - w_t = E_t \sum_{i=1}^{\infty} \rho^i (r_{t+i} - \Delta c_{t+i}) \quad (12)$$

Eq. (12) links the log consumption-wealth ratio with future market return and the future consumption growth, suggesting that a higher log consumption-wealth ratio at this period must forecast either higher returns on the market portfolio at future periods or low future consumption growth rates.

Given that aggregate wealth W_t is the sum of financial asset A_t and human capital H_t , the log linear approximation of W_t is a convex combination of the log-linear approximation of A_t and H_t ,

$$w_t \approx \omega a_t + (1 - \omega) h_t, \quad (13)$$

where ω equals the average share of asset holdings in total wealth, A/W . If aggregate labor income Y_t can describe the non-stationary component of human capital H_t (see Lettau and Ludvigson (2001a) for details), then we can obtain the following relationship between log consumption-aggregate wealth ratio

$$c_t - \omega a_t - (1 - \omega) y_t = E_t \sum_{i=1}^{\infty} \rho^i [\omega r_{a,t+i} + (1 - \omega) r_{h,t+i} - \Delta c_{t+i}] + (1 - \omega) z_t \quad (14)$$

Assuming all terms on the right-hand side of Eq. (14) are stationary, then the left-hand side must also be stationary, implying c_t , a_t , y_t must have cointegration relation with a cointegrating vector $(1, -\omega, \omega - 1)$. We now denote \widehat{cay}_t as the left side of Eq. (14), $c_t - \omega a_t - (1 - \omega) y_t$. This equation suggests that as long as expected future returns on human capital $r_{h,t+i}$ and consumption growth Δc_{t+i} are not too volatile, or if they have high correlation with expected future returns on assets, then \widehat{cay}_t should help forecast the expected future asset returns.

⁴ Individuals, usually in empirical research, are assumed to be aggregated into a single representative agent economy (see Campbell, Lo and MacKinlay (1997), p.304).

Eq. (14) suggests that \widehat{cay}_t has positive linear relation with the excess stock market return. To examine the implication of the single-state-variable model for the predictability of returns on the market portfolio, the regression equation is as follows:

$$E_t[r_{i,t+1}^e] = \alpha + \alpha_1 z_t + \beta_2 \widehat{cay}_t, \quad (15)$$

where $E_t[r_{i,t+1}^e]$ is one-quarter ahead expected excess stock market returns; α is a constant, α_1 is the vector of constant slope coefficients of instrumental variables, and β_2 is the constant slope coefficient.

Accordingly, the model for expected one-period returns in Eq. (15) can be easily extended to a model for expected returns over multiple periods. If \widehat{cay}_t are highly persistent, they should be able to predict multi-period returns. We write expected K -period excess returns as

$$E_t[\sum_{k=1}^K r_{i,t+k}^e] = \alpha^K + \alpha_1^K z_t + \beta_2^K \widehat{cay}_t, \quad (16)$$

where α_1^K is a vector of coefficients and β_2^K are constant slope coefficients.

2.3. A Unified CCAPM with Both State Variables

In this sub-section, we show that both scr_t and \widehat{cay}_t are complementary state variables in the CCAPM. Intertemporal marginal rate of substitution m_{t+1} in Eq. (5) can also be approximated as follows (Lettau and Ludvigson 2001b):

$$m_{t+1} \approx \delta \{1 - \gamma g \lambda(scr_t) - \gamma(\varphi - 1)(scr_t - \overline{scr}) - \gamma[1 + \lambda(scr_t)]\Delta c_{t+1}\}, \quad (17)$$

where scr_t is the log surplus consumption ratio; γ is the parameter of utility curvature; g is the average consumption growth rate; φ is the habit persistent parameter, and $\lambda(scr_t)$ is the sensitivity function; δ is the subjective rate of time preference.

$\lambda(scr_t)$ may be a function of unobservable variables, but their variation should be captured by suitable proxies for time-varying risk premia. Lettau and Ludvigson (2001b) suggest that consumption-wealth ratio, \widehat{cay}_t , may be a good proxy because it not only captures representative agents' expectations of future returns of market portfolio but also may play a role in linear factor models with time-varying coefficients of CCAPM. Assuming $\lambda(scr_t)$ is a linear function of \widehat{cay}_t and scr_t , we may write an approximate form of the risk aversion as follows:

$$\lambda(scr_t) = a + b \cdot \widehat{cay}_t + d \cdot scr_t^5. \quad (18)$$

Substitute Eq. (18) into Eq. (17), we have

$$m_{t+1} \approx \delta \{1 - \gamma g(a + b \cdot \widehat{cay}_t + d \cdot scr_t) - \gamma(\varphi - 1)(scr_t - \overline{scr}) - \gamma(1 + a + b \cdot \widehat{cay}_t + d \cdot scr_t)\Delta c_{t+1}\} \quad (19)$$

Unlike Lettau and Ludvigson (2001b), we show that \widehat{cay}_t and scr_t can be unified in the consumption CAPM and may be used together to predict returns. Eq. (19) can be rewritten as

$$m_{t+1} \approx \alpha + \beta_1 scr_t + \beta_2 \widehat{cay}_t + \beta_3 \Delta c_{t+1} + \beta_4 \cdot (scr_t \Delta c_{t+1}) + \beta_5 \cdot (\widehat{cay}_t \Delta c_{t+1}), \quad (20)$$

where α is constant, β_1 , β_2 , β_3 , β_4 and β_5 are constant slope coefficients. Eq. (20) implies that excess stock market returns should have a linear relationship with both the log consumption-wealth ratio, \widehat{cay}_t , the log surplus consumption ratio, scr_t . Thus the regression equation can be expressed as

⁵ Such that $m_t = a_t + b_t z_t$, where the scaling/conditioning variables z_t include both \widehat{cay}_t and scr_t . It can be demonstrated that $\lambda(scr_t)$ is a linear (negative) function of scr_t .

$$E_t[r_{i,t+1}^e] = \alpha + \beta_1 scr_t + \beta_2 \widehat{cay}_t, \quad (21)$$

where α is constant, β_1 , β_2 , β_3 and β_4 are constant slope coefficients. Similarly, the regression equation over long horizons can be expressed:

$$E_t\left[\sum_k^K r_{i,t+k}^e\right] = \alpha^K + \beta_1^K scr_t + \beta_2^K \widehat{cay}_t, \quad (22)$$

where α^K is a vector of constants and β_1^K and β_2^K are constant slope coefficients.

2.4 CCAPM under Incomplete Market Integration

We now move to the derivation of the international version of the CCAPM with the state variables \widehat{cay}_t and/or scr_t . Stultz (1981a, b) argues that if we assume international markets are completely integrated and all the markets completely share the consumption risk, asset prices from all countries are determined by one common stochastic discount factor. On the other hand, in a completely segmented capital market, asset prices from each country should reflect their own countries' stochastic discount factor. Australia is relatively small and open country, so its asset pricing models should be determined by the local as well as the world stochastic discount factor. We consider CCAPM based on partial market integration. Market-based partial integration tests have been conducted by a number of researchers such as Chan et al. (1992) and Dumas et al. (2003).

Li and Zhong (2005) point out that, under the assumption of partial market integration, the consumption-based model can be described as follows:

$$E_t[r_{i,t+1}^e] = -\frac{1}{2}\sigma_{it}^2 + \phi_t \gamma_w [1 + \lambda(scr_{wt})] \text{cov}_t(r_{i,t+1}^e, \Delta c_{w,t+1}) + (1 - \phi_t) \gamma [1 + \lambda(scr_t)] \text{cov}_t(r_{i,t+1}^e, \Delta c_{t+1}) \quad (23)$$

where $E_t[r_{i,t+1}^e]$ is expected excess local stock market return; σ_{it}^2 is local variance of excess stock market return; ϕ_t is the fraction of local country's expected returns at time t that are related to their covariance with world consumption, if the market is partially integrated, $0 < \phi_t < 1$; γ_w and $\lambda(scr_{wt})$ are the parameter of the world consumption curvature and the world consumption sensitivity function, respectively; γ and $\lambda(scr_t)$ are the parameter of the local consumption curvature and the local consumption sensitivity function, respectively; $\Delta c_{w,t+1}$ and Δc_{t+1} stand for world consumption growth rate and local consumption growth rate, respectively. In this paper, we use the U.S. consumption variables to proxy for the world consumption variables.

Eq. (23) suggests that expected excess market returns are inversely related to the lagged world and local surplus consumption ratios. Linear approximations to the sensitivity function $\lambda(scr_{wt})$ and $\lambda(scr_t)$ imply that the expected excess return on market returns can be written as

$$E_t[r_{i,t+1}^e] = \alpha + \alpha_1 z_t + \beta_{1w} scr_{wt} + \beta_1 scr_t, \quad (24)$$

where scr_{wt} and scr_t represent the world and local log surplus consumption ratios, respectively, and z_t is a vector of information variables. The slope coefficients β_{1w} and β_1 are constants. Here, scr_{wt} is orthogonal to scr_t . The time-varying Jensen's alpha, $\alpha_1 z_t$, captures the time-varying degree of integration and time-varying conditional variances and covariance as well as the linear approximation error in Eq. (24).

Similarly, the model for expected one-period returns in Eq. (24) can be easily extended to a model for expected returns over multiple periods. If the surplus consumption ratios are highly persistent, they should be able to predict multi-period returns. We write expected K -period excess returns as

$$E_t\left[\sum_k^K r_{i,t+k}^e\right] = \alpha^K + \alpha_1^K z_t + \beta_{1w}^K scr_{wt} + \beta_1^K scr_t, \quad (25)$$

where α_1^K is a vector of constants and β_w^K and β_1^K are constant slope coefficients. In addition, expected returns at each horizon K should be inversely related to the lagged world and local log surplus consumption ratios, $\beta_w^K < 0$ and $\beta_1^K < 0$ if β_w and $\beta_1 < 0$, respectively.

In a similar manner, we can construct the predicting equation for returns using world and local consumption-wealth ratios. One-quarter-ahead regression equation is:

$$E_t[r_{i,t+1}^e] = \alpha + \alpha_1 z_t + \beta_{2w} \widehat{cay}_{wt} + \beta_2 \widehat{cay}_t \quad (26)$$

Extending to K -periods, expected cumulative excess returns can be expressed as

$$E_t\left[\sum_k^K r_{i,t+k}^e\right] = \alpha^K + \alpha_1^K z_t + \beta_{2w}^K \widehat{cay}_{wt} + \beta_2^K \widehat{cay}_t \quad (27)$$

With the four state variables, the econometric model takes the form:

$$E_t\left[\sum_{k=1}^K r_{i,t+k}^e\right] = \alpha^K + \alpha_1^K z_t + \beta_1 scr_t + \beta_{1w} scr_{wt} + \beta_2 \widehat{cay}_t + \beta_{2w} \widehat{cay}_{wt} \quad (28)$$

3. Data

As discussed above, the key state variables for return predictability test are the log surplus consumption ratio and the log consumption-wealth ratio. This section describes how we compile the data for these key state variables and other financial data. Our macroeconomic data include household consumption (non-durable goods and service), after-tax labor income and net household wealth. Our financial data include AllOrd stock market returns, ASX/S&P200 stock market returns, dividend yield, earnings per shares, relative short term bond rate, and term spread between long term government bond and short term government bond. We also report summary statistics of the variables and conduct unit root test for macroeconomic variables and test their cointegration relationship.

3.1. Key State Variables

Macroeconomic data usually only exist in lower frequency such as quarterly or annually. In Australia, Australia Bureau of Statistics (ABS) maintains a good record of macroeconomic data. Our consumption, wealth and labor income data are constructed from the time series spreadsheets from AusStats Database⁶. These variables are only available in quarterly or annually. For this paper, we use the data dating back to the fourth quarter of 1976 (1976Q4) and until the second quarter of 2004 (2004Q2), which yields 111 observations. The data used here are quarterly, seasonally adjusted, real per capita data, measured in 1989-90 dollar. See Appendix A for detailed description of how aggregate consumption, wealth and labor income are constructed.

We employed augmented Dickey-Fuller (1979) and Philips-Perron (1988) Unit Root test in the series of household consumption, labor income and net household wealth. We find there is only one unit root in each of these three series. Next we move to test whether there is any cointegration relationship among these three variables. To do this, we conduct two kinds of cointegration test: one is Phillips-Ouliaris (1990) residual-based cointegration test, which is to discern whether there is at least one cointegration vector among these three variables; the other test is a more popular one: Johansen's (1988, 1991) L-Max test and trace statistics test, which will tell us the number of cointegration vectors of the long-term relationship. Both tests suggest there is only one cointegration vector among the three variables. The results of Phillips-Ouliaris cointegration test and Johansen cointegration test are given in Panel A and Panel B of Appendix B, respectively.

Cointegration tests suggest that there is a shared trend in consumption, labor income and net asset wealth. In order to examine the predictability of stock market returns using \widehat{cay}_t , we should

⁶ These series can be retrieved at <http://www.abs.gov.au/ausstats/abs@.nsf/w2.3.1?OpenView>.

estimate the parameters of the cointegration relation. Due to endogenously determined nature of c_t , a_t and y_t series, we use the single equation procedure suggested in Stock and Watson (1993) and use the dynamic least squares (DLS) estimates with Newey and West (1987) to correct for any residual serial correlation,

$$c_t = \alpha + \beta_a a_t + \beta_y y_t + \sum_{i=1}^k b_{ai} \Delta a_{t-i} + \sum_{i=1}^k b_{yi} \Delta y_{t-i} + \varepsilon_t . \quad (29)$$

Ordinary Least Square (OLS) estimate of Eq.(29) produces the super-consistent estimate of β_a and β_y of cointegration parameters (Lettau and Ludvigson 2001). Adding leads and lags of the first difference of net asset wealth and labor income will capture the effects of regressor endogeneity in the linear regression of consumption on asset wealth and labor income. From DLS estimation of Eq.(29), we can obtain the estimated trend deviation $\widehat{cay}_t \equiv c_t - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, where ‘hat’ means estimated parameter.

Using quarterly data from 1976Q4 to 2004Q2, we obtain the estimated coefficients of the trend deviation (Corresponding t-statistics are given below in the parenthesis) of constant, net asset wealth and labor income:

$$c_t = 1.476 + 0.405a_t + 0.239y_t \quad (30)$$

(3.06) (11.85) (2.29)

$$\text{Thus } \widehat{cay}_t = c_t - 0.405a_t - 0.239y_t .$$

Australia market is an open but small market in the world. World business cycle should have some impact on Australian stock market returns. Thus, we add the world surplus consumption ratio and the world consumption–wealth ratio as pricing factors for Australian stock market returns. However, it is hard to construct the world consumption-wealth ratio due to the lack of world data on household wealth. In this paper, we use the U.S. surplus consumption ratio and the U.S. consumption-wealth ratio to proxy for the world surplus consumption ratio and the world consumption-wealth ratio, respectively. This is because the U.S. plays a significant role in Australian foreign inward investment. The U.S. is the largest source of foreign investment in Australia, accounting for around one-third of total foreign investment in Australia.⁷

The U.S. consumption-wealth ratio can be downloaded from the website of Martin Lettau⁸, which provides quarterly data from the fourth quarter of 1951 to the second quarter of 2003. The variables which are used to construct U.S. consumption-wealth ratio - consumption, labor income, household net wealth – are log real per capita data. The U.S. surplus consumption data are constructed in the same manner as in Campbell and Cochrane (1999).

3.2. Financial Data

For stock market index, there are two commonly used indices: AllOrd Index and ASX/S&P 200 Index. AllOrd Index is from the Centre for Research in Finance (CRIF) database of the Australian Graduate School of Management (AGSM), which is dating back to December 1979 with base index of 500 in that month. ASX/S&P 200 index is collected from the bulletin statistics of Reserve Bank of Australia (RBA) with base index of 500 at December 1979. They are monthly data, so we convert them into quarterly data using the average value of the three months in each quarter. AllOrd Index is the value weighted price index for the companies traded in Australian Stock Exchange (ASX) which should provide a better proxy for nonhuman components of household asset wealth than ASX/S&P 200 index. We try stock market returns using both AllOrd Index and ASX/S&P 200 index, and the empirical

⁷ See Australian Bureau of Statistics 2003 Publication, 5352.0, *International investment position, Australia: Supplementary country statistics*.

⁸ Quarterly \widehat{cay}_t data can be retrieved from Martin Lettau’s Webpage: <http://pages.stern.nyu.edu/~mlettau/>.

results are not sensitive to the type of index used. We deflate the stock market index by CPI to get the real stock market return. Stock market returns are log returns:

$$r_t = \log(AllOrd_t) - \log(AllOrd_{t-1}), \quad (31)$$

where *AllOrd* is the series of All Ord Index.

The cross-sectional 24 industry index data are also from AGSM CRIF data base, which are adjusted for franking credits, and share issues and reconstructions. They dates back from December 1973. The prices given are the price relatives, so we convert them back to the prices with the base price of 1 in December 1973. To compute the quarterly returns, we use the price of last month of the quarter as that quarter's price. The data of the telecommunications industry, only becomes available after the second quarter of 1985, to obtain the non-missing value data, we use 1985Q2 to 2002Q3 as the estimation period for the cross-sectional regressions.

For risk-free rate, we use the short-term 2-year government bond as a proxy. Quarterly and monthly 2-year government short-term bond yields are also available in IFS until June 2004. Let us denote r_{mt} as the log real return of the stock market index, and r_{ft} as the log real return on the risk-free rate, then log real excess return on the stock market is $r_t^e = r_{mt} - r_{ft}$.

The local information variables include log dividend yield, dp_t ; log dividend payout ratio, de_t ; detrended short-term government bond return, $RREL_t$; government bond term spreads, TRM_t . It is well documented that these information variables can forecast excess aggregate market returns over long horizons (e.g. Shiller 1984; Fama and French 1988; Lamont 1988; Campbell 1987; Fama and French 1989).

The quarterly data of the dividends yield and the dividend payout ratio for the Austrian stock market index is only available in recent years in the database. Fortunately, Shares magazine and its predecessors, *SXJ* and *the Australian Stock Exchange Journal*, maintain a good record of average dividend yields and PE ratio of all the traded companies in the Australian Stock Exchange (ASX). We hand collected the dividend yields and PE ratios from January 1978 until August 2004. Thus, dividend payout ratio can be easily obtained by

$$\text{dividend payout ratio} = \text{dividend yields} * \text{PE ratio} / 100. \quad (32)$$

We also convert monthly data to quarterly data.

Detrending the short term Treasury bill rate is used by a number of researchers such as Campbell (1991) and Hodrick (1992) and Lettau and Ludvigson (2001a) to predict the U.S. stock market return. In light of this, we use the short-term government bond rate, which is 2-year government bond rate minus 12 month backward moving average, to predict Australian stock market returns.

Term spread, the difference of long-term government bond yield and short-term government bond yield, is also added as information variable to predict the stock market return. Term spread is 15-year government bond yield minus 2-year short-term government bond yield.

For world information variables, we include the U.S. term spread, $TRMW_t$ and the relative Eurodollar rate, $REURO_t$, whose empirical performances have been documented in Ferson and Harvey (1993) and Bekaert and Harvey (1995). The U.S. term spread is obtained from the Federal Reserve Bank of St Louis, computed as the U.S. 10-year bond yield minus the 3-month U.S. bill rate. The relative Eurodollar rate is obtained from International Financial Statistics, calculated as the three-month Eurodollar rate minus a one-year moving average.

Preliminary regression results (not reported but available upon request) show that among the four local information variables, term spread dominates the predictability of excess stock returns with highly significant coefficients at intermediate and long horizons. Other information variables do not have significant forecasting power for excess returns. Nevertheless, we include all four information variables in our predictability to be compatible with previous literature. The world information variables have the predictive power for stock returns on most horizons.

Table 1: Summary Statistics

	r_{t+1}^e	dp_t	de_t	$RREL_t$	TRM_t	Δc_{t+1}	scr_t	scr_{wt}	\widehat{cay}_t	\widehat{cay}_{wt}
Panel A: Correlation Matrix										
r_{t+1}^e	1									
dp_t	0.035	1								
de_t	-0.016	0.418	1							
$RREL_t$	-0.039	0.139	-0.056	1						
TRM_t	0.003	-0.236	-0.028	-0.486	1					
Δc_{t+1}	-0.001	-0.100	-0.004	-0.113	0.136	1				
scr_t	-0.208	0.379	0.094	0.177	-0.050	-0.216	1			
scr_{wt}	0.101	-0.523	-0.324	0.007	-0.240	0.055	-0.268	1		
\widehat{cay}_t	0.137	-0.384	-0.422	-0.302	0.430	-0.169	-0.109	-0.082	1	
\widehat{cay}_{wt}	0.020	0.235	-0.006	-0.099	0.093	-0.033	-0.192	-0.189	-0.052	1
Panel B: Univariate Summary Statistics										
Mean	-0.004	1.436	-0.406	-0.060	0.001	0.005	-3.475	-6.550	1.823	0.725
Standard Error	0.085	0.259	0.253	1.073	0.002	0.007	0.314	0.789	0.025	0.013
Autocorrelation	0.052	0.923	0.903	0.741	0.835	-0.153	0.741	0.938	0.920	0.862

Notes: r_{t+1}^e is quarterly log excess return on AllOrd index; dp_t is the log dividend yield; de_t the log dividend payout ratio; $RREL_t$ is the relative short term government bond rate; TRM_t is the government bond spread between long-term government bond and short term government bond; Δc_{t+1} is the consumption growth rate at time t+1; $\widehat{cay}_t = c_t - 0.405a_t - 0.239y_t$, where c_t is log consumption, a_t is the log of household net asset wealth, and y_t is log after-tax labor income; \widehat{cay}_{wt} is the world consumption-wealth ratio; scr_t is the surplus consumption ratio of Australia, and scr_{wt} is the world surplus consumption ratio. The sample period is from the fourth quarter of 1979 to the second quarter of 2004.

3.3. Summary Statistics

Table 1 has two panels: the correlation matrix and univariate summary statistics. The quarterly variables include log excess return on stock market index r_{t+1}^e , log dividend yield dp_t , log dividend payout ratio de_t , the detrended short term government bond rate $RREL_t$, government bond term spread TRM_t , consumption growth rate Δc_{t+1} , the local surplus consumption ratio scr_t , the world surplus consumption ratio scr_{wt} , local consumption-wealth ratio \widehat{cay}_t , and the world consumption-wealth ratio \widehat{cay}_{wt} . The sample period is from the fourth quarter of 1979 to the second quarter of 2004.

Panel A demonstrates that excess return on the stock market is negatively related the local surplus consumption ratio scr_t , but positively correlated with the local consumption-wealth ratio. The sign of the correlation is consistent with the theory we discussed in Section 2. The state variables scr_t , scr_{wt} , \widehat{cay}_t , and \widehat{cay}_{wt} are moderately correlated with the four information variables, therefore, we orthogonalize the information variables to the state variables in the following predictability tests.

Panel B suggests that relative to the mean, the variation of scr_t and \widehat{cay}_t is less than that of all other variables. Panel B also presents the autocorrelation of the variables at lag 1. Except excess stock market return and consumption growth rate, all other variables exhibit higher autocorrelation. The high persistence property of the independent variables may be helpful for forecasting excess market returns over long horizons.

4. Predictability Results

4.1. Single-State-Variable Forecasting Regressions

Now, we move to examine the predictive power of scr_t and \widehat{cay}_t and other information variables for the aggregated stock market returns in long horizons. We follow Harvey (1989) to test the null hypothesis that the conditional covariance in Eq. (7) is constant. First, we regress market excess return on the information variables to obtain residuals, then we regress the product of the regression residuals and consumption growth on the information variables, and conduct the F-test. Our result rejects the null hypothesis, thus concluding that the conditional covariance between market excess returns and consumption growth is constant ($\chi^2 = 3.29$, $p\text{-value} = 0.51$). Table 2 reports the OLS regression estimation results using single state variable: the log surplus consumption ratio, scr_t , and the log consumption-wealth ratio, \widehat{cay}_t , and/or other information variables as predictive variables. We run the following least square regressions using full sample over the horizons spanning from 1 to 16. The dependent variable is cumulative K -period excess market returns: $\sum_{k=1}^K r_{t+k}^e$. The information variables are: the log dividend yield, dp_t ; the log dividend payout ratio, de_t ; the relative short term government bond rate, $RREL_t$; the government bond term spread, TRM_t . Panel A shows the results of the regression with the state variable but without information variables; Panel B shows the results of the regressions with both the state variable and information variables. Each information variable is orthogonalized to the state variable by using the fitted residuals from the regression of that information variable on the state variable. Table 2 also reports the adjusted R^2 , and Newey-West (1987) adjusted t-statistics to account for any residual serial correlation. Newey-West adjusted t-statistics are placed in parenthesis under the estimated coefficients, and the adjusted R^2 of the regression is placed in the square brackets below the t-statistics.

Table 2: Single-State-Variable Forecasting Regressions

Regression	Regressors	Regression Horizons							
		1	2	3	4	6	8	12	16
Panel A: Without Information Variables									
1	scr_t	-0.0532 (-2.724) [0.038]	-0.0529 (-1.178) [0.012]	-0.0266 (-0.407) [-0.007]	-0.0009 (-0.012) [-0.011]	0.0325 (0.410) [-0.008]	0.0749 (0.915) [0.003]	0.0751 (0.643) [-0.001]	0.1372 (0.748) [0.018]
2	\widehat{cay}_t	0.5667 (0.856) [0.006]	1.5494 (1.432) [0.047]	2.5077 (1.743) [0.089]	3.5428 (2.154) [0.139]	4.7525 (2.361) [0.191]	5.6061 (2.532) [0.236]	5.0161 (1.576) [0.140]	2.9225 (0.819) [0.032]
Panel B: With Information Variables									
3	scr_t	-0.0518 (-2.399) [0.013]	-0.0508 (-1.046) [-0.008]	-0.0246 (-0.386) [-0.002]	0.0014 (0.021) [0.014]	0.0355 (0.566) [0.069]	0.0958 (1.644) [0.195]	0.1045 (1.365) [0.284]	0.1545 (1.523) [0.386]
4	\widehat{cay}_t	0.6152 (0.806) [-0.024]	1.5963 (1.313) [0.044]	2.4461 (1.560) [0.119]	3.3794 (2.007) [0.199]	4.2227 (2.114) [0.225]	4.7969 (2.090) [0.297]	3.7232 (1.279) [0.364]	1.4793 (0.475) [0.430]

Notes: This table presents the results from the regression of the long horizon excess market returns on lagged variables. K denotes the return horizon in quarters, spanning from 1 to 16. The dependent variable is the cumulative excess market returns over K period: $\sum_{k=1}^K r_{t+k}^e$. The state variables are one-quarter lagged values of the following

variables: log consumption-wealth ratio $\widehat{cay}_t = c_t - 0.405a_t - 0.239y_t$, where c_t is log consumption, a_t is the log of household net asset wealth, and y_t is log after-tax labor income; and surplus consumption ratio of Australia, scr_t , which is derived from modified Campbell and Cochrane (1999) model. The informational variables are: dp_t is the log dividend yield; de_t is the log dividend payout ratio; $RREL_t$ is the relative short term government bond rate; TRM_t is the government bond term spread, which equals 15 year government bond yield minus 2 year short term government bond yield. Panel A shows the regression results with the state variable but without information variables; Panel B shows the regression results with both the state variable and information variables. The information variables are orthogonal to the state variables. Significant coefficients at the 5% (10%) significance level are highlighted in **bold** (*italics*) face. Newey-West adjusted t-statistics are placed in parenthesis under the estimated coefficients. The adjusted R^2 of the regression is placed in the square bracket below the t-statistics. The regression sample period is from the fourth quarter of 1979 to the second quarter of 2004.

Regression 1 shows the explanatory power of the log surplus consumption variable, scr_t , which is derived from modified Campbell and Cochrane (1999) model. Here, we use the parameter of the curvature of risk aversion $\gamma=2.0$, as suggested by Campbell and Cochrane (1999); the habit persistence parameter $\phi=0.90$, the same value used by Li and Zhong (2005). The result shows that scr_t can predict excess market returns in the very short horizon. At quarter 1, the estimated coefficient is -0.05, Newey-West adjusted t-statistics is -2.72 and scr_t can explain 3.8% of the variation of the excess stock returns. However, scr_t hardly has any predictive power of for excess market returns over intermediate and long horizons. The adjusted R^2 at intermediate horizon is negative and negligible over long horizons. The estimated coefficient is not significant at 10% level.

Our finding that the estimated coefficient of scr_t at short horizons is negative is consistent with the theory. Under the assumption of i.i.d of the growth rates of consumption and dividends, Campbell and Cochrane (1999) and Li (2001) point out that expected excess stock returns are determined by a single state variable – the surplus consumption ratio, and expected excess returns should be inversely

related to the state variable because high surplus consumption at the business cycle troughs are associated with low investor risk aversion, thus lowering the required rate of returns.

Regression 2 of Table 2 shows the forecastability of log excess stock market returns over long horizon using \widehat{cay}_t as a single state variable. The predictive power of \widehat{cay}_t is quite strong in the intermediate horizons (from 1 year to 2 year). The adjusted R^2 has jumped monotonically from quarter 1 to quarter 8, partly because the returns are overlapping returns. At year 2, the predictive effect of \widehat{cay}_t on accumulated excess returns is quite large; the point estimate of the coefficient on \widehat{cay}_t is about 5.6. Newey-West adjusted t-statistics is 2.5 and \widehat{cay}_t can explain nearly 24% of the variation of the accumulated excess stock returns. At short horizons, \widehat{cay}_t has little explanatory power, however, the estimated coefficients become marginally significant over three quarters and \bar{R}^2 jumps to 9%. In addition, \widehat{cay}_t is losing explanatory power after 2 years, and the coefficient, adjusted t-statistics, and adjusted R^2 all fall. \widehat{cay}_t 's low forecasting power at short horizons may be driven by its marginal predicting power of future consumption growth at short horizons (the results are available upon request).

It is not surprising that the coefficient of \widehat{cay}_t is positive, which is in accordance with the theory. As suggested by Eq. (12), a higher log consumption wealth ratio at this period must forecast either higher returns on the market portfolio at future periods or lower future consumption growth rate. \widehat{cay}_t almost has no predicting power of consumption growth (result is not reported), thus, a higher log consumption-wealth ratio at this period must forecast higher returns on the market portfolio at future periods. Therefore, consumption trend deviation should covary positively with excess stock returns. Moreover, economic intuition indicates that, when investors expected low future returns on assets, they will drop today's consumption temporarily below the long term relationship among consumption, asset and wealth to secure future higher consumption. Therefore, trend deviation \widehat{cay}_t and excess stock returns should have positive covariance.

In Panel B, four information variables: dp_t , de_t , $RREL_t$, TRM_t are orthogonalized to our key state variables. Adding information variables to the regression equations with scr_t and \widehat{cay}_t , the regression result is robust, as shown in Regression 3 and 4. However, adjusted R^2 has risen significantly over intermediate and long horizons, which is mainly driven by the term spread, TRM_t .

4.2. Two-State-Variable Forecasting Regressions

Regression 1 shows the log surplus consumption ratio, scr_t , only predicts excess stock market return one quarter ahead. Regression 2 suggests the log consumption-wealth ratio, \widehat{cay}_t , can strongly predict variation of excess stock market return on the intermediate horizons. Eq. (22) gives the regression equation over long horizons using factors scr_t and \widehat{cay}_t . The results are shown in Regression 5 of Table 3. scr_t can still only forecast one quarter ahead excess market returns, and it has no forecasting power beyond two quarters ahead. \widehat{cay}_t can predict variation of aggregate stock market returns over intermediate horizons. Compared to Regression 2, adding scr_t into the regression equation makes the coefficient of \widehat{cay}_t at year 3 significant at 5% significance level. Using both of them increase the explanatory power for variation of excess stock returns, as \bar{R}^2 increases. Using both \widehat{cay}_t and scr_t can predict 27.4% of variation of excess stock returns over 2 years horizon, which is 3.8% higher than the one using \widehat{cay}_t as a sole variable. At other horizons, the fraction of the predictable variation of excess stock market returns also rise.

In Regression 6 of Panel B, we add information variables into regressors other than scr_t and \widehat{cay}_t . The result is robust; however, the adjusted R^2 rises significantly over intermediate and long horizons, which is mainly driven by the term spread, TRM_t .

4.3. Forecasting under Incomplete Market Integration

Australia is a small but open market. The expected returns on the Australian equity market should be affected by the global price of consumption risk. In this section, we investigate whether aggregate stock market returns in Australia is affected by the world consumption fundamentals. Here, we use the U.S. log consumption-wealth ratio and the U.S. log surplus consumption ratio to proxy the world counterparts.

Table 4 presents the results from the regression of the long horizon excess market returns on lagged variables under the assumption of incomplete market integration. The state variables are the local consumption-wealth ratio, the local surplus consumption ratio, the world consumption-wealth ratio and the world surplus consumption ratio. Panel A shows the results of the regression with the state variables but without the information variables; Panel B shows the results of the regression with both the state variables and the information variables.

Table 3: Two-State-Variable Forecasting Regressions

Regression	Regressors	Regression Horizons							
		1	2	3	4	6	8	12	16
Panel A: Without Information Variables									
5	scr_t	-0.0498 (-2.923)	-0.0424 (-1.056)	-0.0096 (-0.150)	0.0251 (0.312)	0.0818 (1.088)	0.1387 (1.524)	0.1539 (1.313)	0.1921 (1.053)
	\widehat{cay}_t	0.4381 (0.681) [0.037]	1.4468 (1.385) [0.051]	2.4859 (1.816) [0.080]	3.6037 (2.336) [0.132]	5.0102 (2.889) [0.201]	6.0692 (3.332) [0.274]	5.6713 (2.187) [0.171]	3.7801 (1.379) [0.077]
Panel B: With Information Variables									
6	scr_t	-0.0493 (-2.769)	-0.0420 (-1.019)	-0.0090 (-0.148)	0.0236 (0.331)	0.0668 (1.042)	0.1357 (1.927)	0.1491 (1.666)	0.1808 (1.667)
	\widehat{cay}_t	0.4542 (0.635) [0.030]	1.4707 (1.300) [0.069]	2.4244 (1.646) [0.117]	3.4468 (2.161) [0.190]	4.4402 (2.355) [0.220]	5.3067 (2.467) [0.314]	4.3218 (1.418) [0.362]	2.1271 (0.721) [0.425]

Notes: This table presents the results from the regression of the long horizon excess market returns on lagged variables. K denotes the return horizon in quarters, spanning from 1 to 16. The dependent variable is the cumulative excess

market returns over K period: $\sum_{k=1}^K r_{t+k}^e$. The state variables are one-quarter lagged values of the following variables:

log consumption-wealth ratio $\widehat{cay}_t = c_t - 0.405a_t - 0.239y_t$, where c_t is log consumption, a_t is the log of household net asset wealth, and y_t is log after-tax labor income; and surplus consumption ratio of Australia, scr_t , which is derived from modified Campbell and Cochrane (1999) model. The informational variables are: dp_t is the log dividend yield; de_t is the log dividend payout ratio; $RREL_t$ is the relative short term government bond rate; TRM_t is the government bond term spread, which equals 15 year government bond yield minus 2 year short term government bond yield. Panel A shows the regression results with state variables but without information variables; Panel B shows the regression results with both state variables and information variables. The coefficients and t-statistics of the four information variables are not reported to save space. The information variables are orthogonalized to both state variables. Significant coefficients at the 5% (10%) significance level are highlighted in **bold (italics)** face. Newey-West adjusted t-statistics are placed in parenthesis under the estimated coefficients. The adjusted R^2 of the regression is placed in the square bracket below the t-statistics. The regression sample period is from the fourth quarter of 1979 to the second quarter of 2004.

Table 4: Forecasting Regressions under Incomplete Market Integration

Regression	Regressors	Regression Horizons							
		1	2	3	4	6	8	12	16
Panel A: Without Information Variables									
7	scr_t	-0.0628 (-2.875)	-0.0633 (-1.260)	-0.0311 (-0.427)	0.0001 (0.001)	0.0283 (0.346)	0.0735 (0.858)	0.0672 (0.600)	0.1248 (0.720)
	scr_{wt}	0.0057 (0.357) [0.038]	0.0145 (0.495) [0.010]	0.0235 (0.541) [-0.013]	0.0276 (0.467) [-0.017]	0.0165 (0.205) [-0.020]	-0.0083 (-0.092) [-0.010]	-0.1093 (-1.283) [0.035]	-0.1933 (-3.087) [0.138]
8	\widehat{cay}_t	0.6143 (0.909)	1.5984 (1.467)	2.5469 (1.768)	3.5235 (2.157)	4.7200 (2.391)	5.5596 (2.590)	5.0015 (1.645)	3.0231 (0.907)
	\widehat{cay}_{wt}	0.1703 (0.392) [-0.002]	0.3716 (0.578) [0.042]	0.7283 (0.835) [0.087]	1.1472 (1.024) [0.138]	1.6930 (1.111) [0.196]	2.0909 (1.225) [0.246]	4.0921 (2.439) [0.185]	5.2199 (2.572) [0.092]
9	scr_t	-0.0577 (-2.998)	-0.0412 (-0.948)	0.0128 (0.191)	0.0672 (0.817)	0.1205 (1.619)	0.1858 (2.101)	0.1853 (1.968)	0.2290 (1.551)
	scr_{wt}	0.0063 (0.355)	0.0205 (0.680)	0.0381 (0.980)	0.0517 (1.057)	0.0515 (0.801)	0.0352 (0.478)	-0.0558 (-0.720)	-0.1441 (-2.310)
	\widehat{cay}_t	0.4191 (0.608)	1.5100 (1.396)	2.7336 (1.937)	4.0349 (2.515)	5.3554 (3.057)	6.4525 (3.583)	5.6965 (2.230)	3.8275 (1.554)
	\widehat{cay}_{wt}	-0.0609 (-0.128) [0.023]	0.2611 (0.362) [0.038]	0.9521 (0.953) [0.080]	1.6945 (1.317) [0.156]	2.6358 (1.465) [0.223]	3.3326 (1.586) [0.309]	4.3694 (2.323) [0.244]	5.0813 (1.909) [0.236]
10	scr_t	-0.0578 (-2.202)	-0.0538 (-0.959)	-0.0174 (-0.251)	0.0162 (0.257)	0.0414 (0.712)	0.0830 (1.573)	0.0916 (1.925)	0.1645 (1.724)
	scr_{wt}	0.0150 (1.114) [0.036]	0.0319 (1.216) [0.037]	0.0479 (1.296) [0.062]	0.0569 (1.114) [0.088]	0.0396 (0.569) [0.099]	0.0063 (0.090) [0.200]	-0.0714 (-1.277) [0.277]	-0.1384 (-3.304) [0.378]
11	\widehat{cay}_t	0.6536 (0.828)	1.6200 (1.290)	2.4707 (1.524)	3.4263 (1.973)	4.2671 (2.096)	4.7544 (2.059)	3.5960 (1.279)	1.3524 (0.448)
	\widehat{cay}_{wt}	0.1678 (0.383) [-0.034]	0.3682 (0.566) [0.033]	0.7283 (0.833) [0.109]	1.1451 (1.014) [0.194]	1.7232 (1.154) [0.224]	2.1387 (1.330) [0.294]	4.1822 (2.545) [0.368]	5.8084 (2.417) [0.441]
12	scr_t	-0.0558 (-2.757)	-0.0382 (-0.882)	0.0159 (0.271)	0.0704 (1.109)	0.1205 (2.542)	0.1828 (3.120)	0.1833 (3.627)	0.2383 (2.733)
	scr_{wt}	0.0133 (0.833)	0.0350 (1.155)	0.0602 (1.747)	0.0789 (1.972)	0.0775 (1.288)	0.0591 (0.858)	-0.0157 (-0.256)	-0.0897 (-2.097)
	\widehat{cay}_t	0.1773 (0.212)	0.9669 (0.777)	1.8334 (1.228)	2.8908 (1.860)	4.0962 (2.245)	5.1335 (2.433)	3.6288 (1.303)	1.4487 (0.518)
	\widehat{cay}_{wt}	0.0233 (0.044) [0.060]	0.4320 (0.526) [0.142]	1.2090 (1.151) [0.231]	2.0092 (1.621) [0.343]	2.9283 (1.788) [0.308]	3.5946 (1.892) [0.365]	4.8250 (3.065) [0.384]	6.0294 (2.502) [0.442]

Notes: This table presents the results from the regression of the long horizon excess market returns on lagged variables under the assumption of incomplete market integration. K denotes the return horizon in quarters, spanning from 1 to 16. The dependent variable is the cumulative excess market returns over K period: $\sum_{k=1}^K r_{t+k}^e$. The state variables are one-quarter lagged values of

the following variables: the local consumption-wealth ratio $\widehat{cay}_t = c_t - 0.405a_t - 0.239y_t$, where c_t is log consumption, a_t is the log of household net asset wealth, and y_t is log after-tax labor income; and the local surplus consumption ratio of Australia, scr_t , which is derived from modified Campbell and Cochrane (1999) model; \widehat{cay}_{wt} is the world consumption-wealth ratio; scr_{wt} is the world surplus consumption ratio. The informational variables are: dp_t is the log dividend yield; de_t is the log dividend payout ratio; $RREL_t$ is the relative short term government bond rate; TRM_t is the government bond term spread, which equals 15 year government bond yield minus 2 year short-term government bond yield. Panel A shows the regression results with state variables but without information variables; Panel B shows the regression results with both state variables and information variables. The information variables are orthogonalized to the state variables. Significant coefficients at the 5% (10%) significance level are highlighted in **bold (italics)** face. Newey-West adjusted t-statistics are placed in the parenthesis under the estimated coefficients and the adjusted R^2 of the regression is placed in the square bracket below the t-statistics. The regression sample period is from the fourth quarter of 1979 to the second quarter of 2002.

First, we examine the role of the world surplus consumption ratio, scr_{wt} . Regression 7 reports the regression using both the world surplus consumption ratio, scr_{wt} and the local surplus consumption ratio scr_t . The estimated coefficient of the world surplus consumption ratio is only significant at the 4 year horizon. Australian excess stock market returns is inversely related to the variation of the world surplus consumption ratio, which is consistent with the theory. The world surplus consumption ratio, scr_{wt} , can predict around 14% of the variation of excess stock returns at the long horizon. The local surplus consumption ratio scr_t can still only predict the excess returns one-quarter ahead.

In Regression 8, we use both the local consumption-wealth ratio and the world consumption-wealth ratio as explanatory variables. Compared to the local consumption-wealth ratio, the predictive power of the world consumption-wealth ratio \widehat{cay}_{wt} mainly resides in the long horizons. The predictive power of \widehat{cay}_{wt} on accumulated excess returns, compared to \widehat{cay}_t , is weak, as the adjusted R^2 can be only 3-5%. As expected, the sign of the estimated coefficients are positive. Compared to Regression 2, using both variables in the regression marginally increases the adjusted R^2 in the intermediate horizons. In the horizon of three years to four years, the explanatory power has risen about 5-6%. Thus, our results suggest that both the local consumption-wealth ratio \widehat{cay}_t and the world consumption-wealth ratio \widehat{cay}_{wt} help predicting the variation of excess stock market returns.

Then we include the local and world surplus consumption ratio as well as the local and world consumption-wealth ratio in the regression equation. The result is shown in Regression 9 of Table 4. The adjusted R^2 improves significantly in the period from intermediate horizons to long horizons than Regression 7 and Regression 8.

In Regression 10, we include information variables: dp_t , de_t , $RREL_t$ and TRM_t into the regression equation apart from the world and local consumption-wealth ratio. Here, the world consumption-wealth ratio is orthogonal to the local consumption-wealth ratio, and the information variables are orthogonal to both the world and local consumption-wealth ratio. The result shows that the predictability of local and world consumption-wealth ratio does not change due to the inclusion of the information variables. However, the adjusted R^2 has risen significantly in the intermediate to long horizons, which is primarily due to the contribution of the explanatory power of TRM_t and dp_t in intermediate to long horizons.

The contribution of the world consumption-wealth ratio and the world surplus consumption ratio is robust to whether the regressions includes information variables or not, as Regressions 11 and 12 indicate. However, the coefficients of the local surplus consumption ratio become positive and significant at the long horizons in Regression 12. The wrong sign of the surplus consumption ratio in the long-horizon regression may be attributed to the famous data measurement error in aggregate consumption as discussed by Campbell and Cochrane (1999).

4.4. Comparison of R-squares

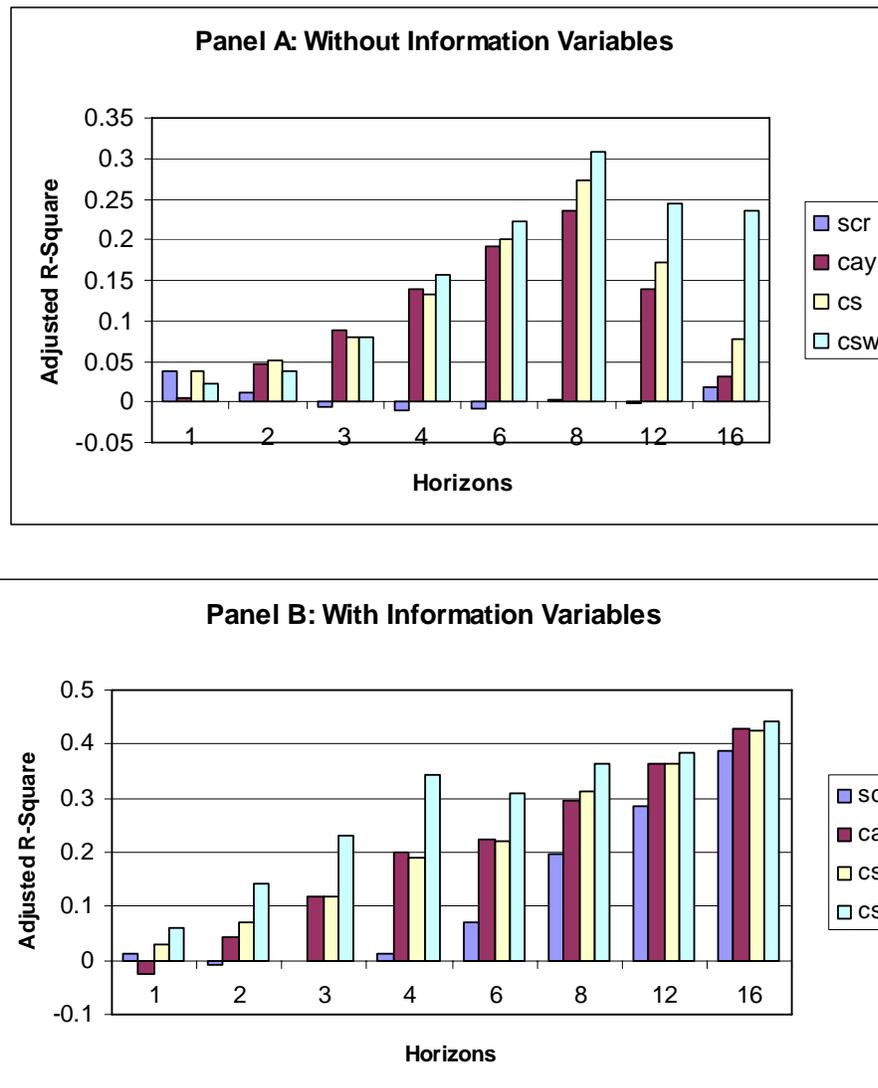
In this section, we pick up which factor at which horizon plays more important role in determining asset pricing in Australia: the local consumption-wealth ratio, the world consumption-wealth ratio, the local surplus consumption ratio, the world surplus consumption ratio, and combined thereof. Figure 1 exhibits the adjusted R^2 from the long horizons regressions using the state variables and/or information variables. Panel A compares the adjusted R^2 of the regressions using the different state variables without information variables; Panel B compares the adjusted R^2 of the regressions using the different state variables with the information variables.

Panel A suggests that the local surplus consumption ratio can only predict excess stock market returns in the very short horizon and the local consumption-wealth ratio in the intermediate horizons. The local consumption-wealth ratio has more predictive power than local surplus consumption ratio, as

suggested by the magnitude of the adjusted R^2 . Combining both the local surplus consumption ratio and the local consumption-wealth ratio even have more explanatory power in almost every horizon considered than the one with only one state variable. The four factors working together perform the best from intermediate to long horizons due to the significance of the world consumption-wealth ratio and the surplus consumption ratio in that periods.

Panel B shows that adding information variables into the regression generally increase the explanatory power of the model except that the ones using both local consumption-wealth ratio and local surplus consumption ratio at 1 quarter (the adjusted R^2 is under 5%). Information variables contribute to predictability most in the long horizons, which is driven by the predictive power of TRM_t in the long horizons.

Figure 1: Adjusted R^2 Comparison



Notes: This figure exhibits the adjusted R^2 from the long horizons regressions using the state variables and/or information variables. Panel A compares the adjusted R^2 of the regressions using the different state variables without information variables; Panel B compares the adjusted R^2 of the regressions using the different state variables with information variables. Legend 'cay' means the regressor is local consumption-wealth ratio; 'scr' means the regressor is local surplus consumption ratio; 'cs' means the regressors are both local consumption-wealth ratio and local surplus consumption ratio; 'csw' means the regressors are local and world consumption-wealth ratios, and local and world surplus consumption ratio.

In short, \widehat{cay}_t is generally a better predictor for long-horizon excess returns perhaps because it suffers less data measurement error than scr_t does (Li, Lu and Zhong 2004). The obstacle of the unobservable component of the consumption-wealth ratio is overcome by the employment of cointegrating relation among observable consumption, asset wealth, and labor earning (Lettau and Ludvigson 2001b). On the other hand, the habit specification underlying the surplus consumption ratio variable is large arbitrary, which may dampen the predictive power of this variable.

4.5. GMM estimation of the explanatory power of the local and world state variables in a partial integration model

To what extent can the local and world state variables and information variables predict stock returns? In order to examine the explanatory power of the above variables, we use the variance ratio. The regression variables in the right hand side of Eq. (27) are orthogonalized, therefore, we can obtain the following variance decomposition of expected excess returns:

$$Var(E_t[\sum_{t=1}^K r_{i,t+K}^e]) = Var(\alpha^K z_t) + Var(\beta_2^K \widehat{cay}_t) + Var(\beta_{2w}^K \widehat{cay}_{wt}). \quad (33)$$

Eq. (33) implies that the portions of the variation of expected K-period excess returns, which can be explained by the local and world log surplus consumption ratios, can be measured respectively by the following variance ratios:

$$0 \leq VR_L^K = \frac{Var(\beta_2^K \widehat{cay}_t)}{Var(\alpha^K z_t) + Var(\beta_2^K \widehat{cay}_t) + Var(\beta_{2w}^K \widehat{cay}_{wt})} \leq 1$$

and

$$0 \leq VR_w^K = \frac{Var(\beta_{2w}^K \widehat{cay}_{wt})}{Var(\alpha^K z_t) + Var(\beta_2^K \widehat{cay}_t) + Var(\beta_{2w}^K \widehat{cay}_{wt})} \leq 1 \quad (34)$$

We use the Hansen's (1982) Generalized Method of Moments (GMM) to evaluate the total portion of the predictable variation in excess returns that is explained by the local surplus consumption ratios and the world surplus consumption ratio. Because the equation for the variance ratio is nonlinear, we cannot use the OLS method. Though nonlinear IV estimation method can solve nonlinear problem, the advantage of using GMM is that the model need not to be homoscedastic and serially independent and the covariance matrix of the averages of sample moments is taken into account for minimizing the GMM criterion function. Table 5 presents the GMM estimation results of the explanatory power of the local and world log consumption-wealth ratio in a partial integration model.

Under the completely integrated world market hypothesis, the expected equity returns in Australia should be positively related to the lagged world consumption-wealth ratio. The estimated coefficient β_{2w}^K should be positive and statistically significant; the coefficient of local log consumption-wealth ratio β_2^K should be statistically insignificant. On the other hand, the partially integrated world market hypothesis indicates that both β_2^K and β_{2w}^K are positive and statistically significant. Table 5 shows that at 4 quarters to 8 quarters ahead, β_{1t}^K is positive and statistically significant at 5% percent level. It is significant at 10% percent level at two to three quarters. The estimated coefficient for the world consumption-wealth ratio β_{wt}^K becomes significant only at year 3 and year 4 (12 - 16 quarters). As expected, the coefficient is positive, which support the hypothesis that there is positive relationship between the expected equity returns and the log consumption-wealth ratio. In short, GMM estimation confirms the above OLS regression results. In the intermediate horizons, the local surplus consumption play a role in predicting expected excess stock returns; in the long horizons, the world consumption rather than the local consumption ratio can predict stock returns.

Table 5: GMM Estimation of the System of Local and World Consumption State Variables

The explanatory power of the local and world log consumption wealth ratio				
Quarter	β_2^K	β_{2w}^K	VR_L^K	VR_w^K
1	0.804 (0.658)	0.157 (0.423)	0.410 (0.426)	0.008 (0.041)
2	1.919 (1.156)	0.347 (0.620)	0.582 (0.340)	0.009 (0.034)
3	2.738 (1.526)	0.712 (0.812)	0.710 (0.333)	0.023 (0.055)
4	3.505 (1.730)	1.149 (1.023)	0.774 (0.332)	0.040 (0.072)
6	4.150 (1.922)	1.748 (1.408)	0.741 (0.348)	0.063 (0.083)
8	4.339 (1.895)	2.233 (1.593)	0.580 (0.279)	0.074 (0.073)
12	3.479 (2.630)	3.989 (1.340)	0.318 (0.381)	0.198 (0.103)
16	1.458 (3.498)	5.211 (1.701)	0.053 (0.260)	0.290 (0.137)

Notes: This table reports the GMM estimation of the following exactly identified system:

$$\begin{array}{l}
 \text{Moment conditions} \\
 u_{1t}^K = \sum_{k=1}^K r_{t+k}^e - (\alpha_0^K + \alpha^K z_t + \beta_2^K \widehat{cay}_t + \beta_{2w}^K \widehat{cay}_{wt}) \\
 u_{2t}^K = [(\alpha^K z_t)^2 + (\beta_2^K \widehat{cay}_t)^2 + (\beta_{2w}^K \widehat{cay}_{wt})^2] VR_L^K - (\beta_2^K \widehat{cay}_t)^2 \\
 u_{3t}^K = [(\alpha^K z_t)^2 + (\beta_2^K \widehat{cay}_t)^2 + (\beta_{2w}^K \widehat{cay}_{wt})^2] VR_w^K - (\beta_{2w}^K \widehat{cay}_{wt})^2
 \end{array}
 \begin{array}{l}
 \text{Orthogonal to} \\
 1, \widehat{cay}_t, \widehat{cay}_{wt}, z_t \\
 1 \\
 1
 \end{array}$$

$\sum_{k=1}^K r_{t+k}^e$ denotes the K-quarter excess market returns with continuous compounding, \widehat{cay}_t is the demeaned variable of the local consumption-wealth ratio $\widehat{cay}_t = c_t - 0.405a_t - 0.239y_t$, where c_t is log consumption, a_t is the log of household net asset wealth, and y_t is log after-tax labor income. \widehat{cay}_{wt} is the component of the demeaned variable of the world consumption-wealth ratio, surrogated by U.S. log consumption-wealth ratio, which is orthogonal to \widehat{cay}_t . z_t is the demeaned first lag of local information variable, which is government bond term spread, TRM_t , and US government bond term spread $TRMW_t$, the relative Eurodollar rate, $REURO_t$. Information variables are orthogonal to \widehat{cay}_t and \widehat{cay}_{wt} . VR_L^K is the fractions of the variance of the K-quarter expected excess returns that are explained by \widehat{cay}_t ; VR_w^K is the fractions of the variance of the K-quarter expected excess returns that are explained by \widehat{cay}_{wt} . The standard deviations of the estimates are placed below the coefficients in parenthesis.

The local variance ratio is quite high in the intermediate horizons, with 77% in four quarters and 58% in eight quarters. Both of them are significant at 5% level. The world variance ratios are very low and statistically insignificant in the short horizon. High local variance ratio reflects the low predictive power of the information variable in the short horizons. It suggests that in the intermediate horizons the changing price of risk at the local level are important in explaining predictable variation of expected domestic stock returns. Table 5 shows that at the longest horizon, year 4, the local variance ratio is only 5% and no longer significant. The world variance ratio is 29% and statistically significant. It implies that the world variance ratio can explain part of the variation of the stock returns, which suggests that the consumption-wealth is an important factor in determining stock returns in the long

horizons, and the variation of stock returns in the long horizons are associated with world business cycle rather than local business cycle.

5. Conclusion

In this study, we use the consumption-based asset pricing model with the log surplus consumption ratio scr_t and the log consumption wealth variable \widehat{cay}_t to examine the predictability of stock market returns in the Australian equity market. We find that that the surplus consumption ratio scr_t can only predict excess stock returns at the very short horizon, one quarter ahead; on the other hand, the consumption-wealth ratio \widehat{cay}_t can predict the variation of excess stock market return at the intermediate horizons (from 1 year to 2 years). The estimated coefficient of scr_t is negative, which is also in accordance with the theory: because high surplus consumption at the business cycle troughs is associated with low investor risk aversion, thus lowering the expected required return. The coefficients of \widehat{cay}_t suggest that excess stock returns have positive correlation with \widehat{cay}_t , which is consistent with economic intuition: when investors expect low future returns on assets, they will drop today's consumption temporarily below the long term relationship among consumption, asset and wealth to secure future higher consumption.

Moreover, including both the surplus consumption ratio and the consumption-wealth ratio into the forecasting regression yields a higher adjusted R^2 , which suggests these two consumption variables are not mutually exclusive, but complementary.

Our empirical results provide international evidence of the predictive power of Campbell and Cochrane's (1999) surplus consumption ratio, scr_t and Lettau and Ludvigson's (2001a) consumption-wealth ratio, \widehat{cay}_t . Moreover, our study adds new insights into the predictability and variation of aggregate stock market returns in the Australian equity market.

In addition to the empirical analysis of local time-varying expected returns, our exploratory investigation of CCAPM under incompletely integrated market yields that Australian asset pricing are partially determined by the world consumption risk. Both the world consumption-wealth ratio and the world surplus consumption ratio have predictive power of excess equity return over long horizons. The international version of CCAPM has more explanatory power than the domestic version of CCAPM.

One interesting point we find that the consumption-wealth ratio have relatively better performance and more explanatory power than the surplus consumption ratio, which is consistent with the findings from Li, Lu and Zhong (2004). The lower predictive power of the surplus consumption ratio may be attributed to serious data measurement errors of aggregate consumption data as discussed in Campbell and Cochrane (1999). Yet, Lettau and Ludvigson (2001b) argue that the construction of the consumption-wealth ratio based on cointegration estimation may have overcome the problems of unobservable variables. Our study enriches the understanding of international consumption-based asset pricing based on a case study of a small open market.

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Appendix A: Macroeconomic Data

The consumption data are for non-durables goods and services. Using non-durables goods and services for consumption data has been used by many researchers (e.g. Lettau and Ludvigson, 2001a; Li, Lu and Zhong, 2004) It is calculated as Total Household Final Consumption Expenditure less Clothing and Footwear, Furnishings and Household Equipment, and Purchase of Vehicles (\$m, seasonally adjusted in current prices), which is taken from series 5206058.1 of AusStats Time Series Spreadsheets.

CPI (Consumer Price Index), from Series 640101b of AusStats Time Series Spreadsheets, is used to deflate all nominal variables in this paper. It is weighted average of all groups index of eight capital cities, with base index 1989-90 = 100.

Aggregate wealth, particularly human capital, is not directly observable. In order to use it for forecasting asset returns, we must find a proxy for human capital. To overcome this obstacle, we use after tax labor income to proxy human capital. We use a number of series from AusStats Time Series Spreadsheets to construct after-tax labor income.

After-tax labor income is defined as wages and salaries plus transfer payment minus labor income tax.

$$INCOME = WAGES + TRANSFERS - \gamma * TAX \quad (40)$$

Wages is quarterly non-farmer wage & salary earners' average earnings. It is constructed from Non-farmer Wage & Salary Earner's average weekly earnings and measures of employment. Average weekly earnings (AWE) are from AusStats Series 1364019 (seasonally adjusted, in \$). WSE is the total number of non-farm civilian wage and salary earners, available from AusStats Series 1364010. ω is the number of weeks in one quarter, calculated as $(1/7)*(365/4)$.

$$WAGES = \omega * AWE * WSE \quad (41)$$

Transfers are constructed as Total Secondary Income Receivable less Social Contributions for Workers Compensation, available from AusStats Series 5206036. γ is the proportion of labor income in the total household income, which is calculated as $WAGES / (\text{Total Primary Income})$. Tax is calculated as the sum of Income Tax Payable and Other Current Tax on income, wealth etc. All above series are available in AusStats Series 5206036.

The labor income we constructed above is aggregate labor income. We deflate this series with Australian Population (available from AusStats Series 1364010) and CPI to get per capita real after-tax labor income.

Quarterly net household wealth data for the period from 1976Q4 to 1999Q3 are taken from Tan & Voss (2003)⁹, which includes financial wealth and non-financial wealth. Using annual net wealth of household balance sheet from AusStats Series 5204050, we extend household wealth data from 1999Q4 to 2004Q2 by interpolation.

⁹ Real per capita net household wealth data can be downloaded at <http://web.uvic.ca/~gvoss/>.

Appendix B: Cointegration Tests

Panel A. Phillips-Ouliaris Test for Cointegration Relationship						
Augmented Dickey-Fuller T-statistics			Critical Value			
			5% Critical Value		10% Critical Value	
-2.879			-1.943		-1.617	
Panel B. Johansen Cointegration Test						
H ₀ : r	L-max Statistics	L-max90	L-max95	Trace Statistics	Trace90	Trace95
0	19.14	18.60	20.97	30.34	26.79	29.68
1	10.03	12.07	14.07	11.2	13.33	15.41
2	1.17	2.69	3.76	1.17	2.69	3.76

Notes: The quarterly sample data spans from 1976Q4 to 2004Q2. Panel A examines the presence of unit root from the cointegrating regression of consumption on after-tax labor income and net household wealth using Philips-Ouliaris (1990) residual-based cointegration test for Australia. Augmented Dickey-Fuller test is applied to the residuals from the regression of consumption (c_t) on wealth (a_t) and labor income (y_t). The optimal lag is one as chosen by the AIC criterion. The critical values are assuming trending series. Significant t-test statistics at the 5% significance level are highlighted in **bold** face. Panel B reports Johansen L-Max and Trace Statistics for cointegration tests among consumption, labor income and asset wealth. A constant is included in the cointegration space. The column labeled “L-max90” and “L-max95” denote the 90% and 95% confidence level of L-max statistics, respectively; the “Trace90” and “Trace95” gives the 90% and 95% confidence level of trace statistics, respectively. “r” is the number of the cointegration relation. Optimal lag is one as chosen by AIC criterion. Significant test statistics at 95% (90%) confidence level are highlighted in **bold (italics)** face. The critical values of the Johansen cointegration tests are obtained from Osterwald-Lenum (1992, Table 1).