Consumption, Wealth and Financial Market

Master's Thesis

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I hereby declare that I have independently written the thesis presented here and that the only resources and materials used are those indicated.

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1 Introduction

Predictability of stock returns is always a disputed topic in finance. In the early 1970s, the efficient markets theory and random walk theory supported the view that returns are unpredictable. If the market is efficient, then market prices already contain most of the available information about the fundamental value of the stocks. This is the so called efficient market hypothesis, as included in Fama (1970). Since the 1980s, however, a lot of empirical work has found out that returns are predictable. Financial variables such as the dividend-price ratio (Fama and French (1988a) and Shiller (1984)), the dividend-earning ratio (Lamont (1998)), the relative bill rate (Campbell (1991) and Hodrick (1992)), the term spread between long-term and short-term bond (Fama and French (1989)), and macroeconomic variables such as the investment-capital ratio (Cochrane (1991)) and the consumption-wealth ratio (Lettau and Ludvigson (2001)) have been documented as the indicators which have predictive power for the excess returns.

As interesting as the predictability of stock returns in finance, are forms of the consumption function in macroeconomics. One of the oldest statistical regularities about the consumption function states that consumer spending is linearly correlated with income. From the 1950s, two similar forms of the consumption function have been accepted by most economists: Milton Friedman's permanent income hypothesis and Franco Modigliani's life-cycle hypothesis. Friedman declares that consumption is decided by the long-term expected income, the permanent income. Modigliani shows that consumption is determined by the sum of net worth, current income and present value of all expected future income. In 1978, Rober E. Hall sharpened the implications of the life-cycle and permanent income hypotheses and showed that only surprises in permanent income can affect current consumption under the rational expectations hypothesis. Therefore, consumption growth is unpredictable. This is the so called random walk hypothesis. Modern research including Campbell and Mankiw (1989), however, have found out that consumption is also determined by transitory income, and not only by permanent income. Thus, consumption growth should be predictable. In order to determine the absolute level of consumption, given either wealth and expected future interest rate, or expected future income flows and interest rates, Campbell and Mankiw (1989) formulated the level of consumption in the consumption-wealth ratio, which is a linear function of the future expected asset return and consumption growth.

The consumption-wealth ratio proposed by Campbell and Mankiw (1989) is an important combining point between consumption and stock returns, macroeconomics and finance. It combines the level of consumption and wealth with the future asset returns and consumption growth. Lettau and Ludvigson (2001) interpret the consumption-wealth ratio not in the same way as Campbell and Mankiw (1989), i.e. as an instrument to determine the current level of consumption by wealth (or income) and asset returns, but as a predictor for either future expected asset returns or future consumption growth, or both. Therefore, the consumption-wealth ratio has combined the development of both macroeconomics and finance, since it shows the predictability of both consumption growth and stock returns. A further important interpretation of the consumption-wealth ratio made by Lettau and Ludvigson (2001) is that the aggregate wealth contains two components, asset holdings (net worth) and Labor income. Based on this assumption, they find the equilibrium relation that aggregate consumption is a linear function of asset holdings (net worth) and labor income. This consumption function is exactly the same as one of the interpretations of the consumption function based on the life-cycle hypothesis of Modigliani, included in Ando and Modigliani (1963). Thus, although the new interpretation of the consumption-wealth ratio made by Lettau and Ludvigson (2001) appears in the 21th century, the very same idea has already been existing for 40 years.

Using U.S. quarterly data from 1952 to 1998, Lettau and Ludvigson (2001) find evidence that the consumption-wealth ratio can predict stock returns, but not consumption growth. The forecasting ability of the consumption-wealth ratio for stock returns is so promising in U.S. data that this thesis investigates the forecasting power of the consumption-wealth ratio for stock returns in German data.

Based on the available quarterly German data from 1971 to 2002, the forecasting analysis does not confirm the evidence that the consumption-wealth ratio can forecast stock returns. However, there is evidence to support the view that the consumption-wealth ratio can predict consumption growth at forecast horizons from 2 to 4 years. This is consistent with the findings of Campbell and Mankiw (1989) which state that consumption growth is predictable. Furthermore, the estimated deviations from the shared trend in consumption, labor income, and assets are better described as transitory movements in asset wealth and consumption than as transitory movements in labor income. In contrast, Lettau and Ludvigson (2001) argue that the deviations from the shared trend in consumption, labor income, and assets are better described as transitory movements in asset wealth than as transitory movements in consumption and labor income.

The first obstacle this thesis tries to overcome is that quarterly time series of household net worth are not available in Germany. Because household net worth is used by Lettau and Ludvigson (2001) for measuring asset holdings, it is very important to find comparable German data for the analysis. Thus, quarterly German data of household net worth are constructed based on the other three time series (private deposits, share capital, and non-financial assets). Since the constructed quarterly data of household net worth may not properly represent the quarterly variation in the unobservable true data, the quarterly private deposit is used as an additional measure of asset holdings, in order to capture the quarterly variations of asset holdings. It turns out that the consumption-wealth ratio based on household net worth has a better performance than the consumption-wealth ratio based on private deposits in the analysis of forecasting stock returns.

Second, the estimated residuals from regression of consumption on labor income and asset holdings contain big positive autocorrelations. These estimation results are obtained from a dynamic least squares (DLS) specification, which adds leads and lags of the first difference of the independent variables to a standard OLS regression of consumption on labor income and asset holdings. Lettau and Ludvigson (2001) argue that the DLS specification can eliminate the effects of regressor endogeneity on the distribution of the least squares estimator. However, strong autocorrelated residuals imply inaccuracy of the DLS specification for cointegrated systems. Therefore, an error correction model (ECM) is additionally used to estimate the consumption-wealth ratio, in which consumption, asset holdings, and labor income are co-integrated. Although the error-correction model (ECM) delivers better estimates for the consumption-wealth ratio, the estimated fluctuations in the consumption-wealth ratio do not forecast stock returns either.

Possible answers for the lack of predictive power of the consumption-wealth ratio for stock returns are: the quarterly variation in the unobservable German data of household net worth cannot be included in the analysis; the German consumption growth is more volatile and at the same time less correlated with stock returns, compared with U.S. consumption growth; Germany is a less capitalized country. The proportion of stock market capitalization to GDP is 58% in Germany, while 135% in the USA, in 2001. This reduces the importance of stock markets for aggregate wealth in Germany. Besides, high holdings of foreign stocks and high pension payments in Germany weaken the link between domestic stock returns and consumption.

The rest of the thesis is organized as follows. The next section presents properties of some important stock return predictors as the dividend-price ratio, henceforth called the dividend yield, the dividend-earning ratio, henceforth called the dividend payout ratio, the relative bill rate, default spread, and term spread. Section 3 presents theories about consumption, which are the theoretical framework for the consumption-wealth ratio. In section 4, the model of the consumption-wealth ratio and its forecasting ability included in Lettau and Ludvigson (2001) is presented. In section 5, German data are used to estimate the deviation from the shared trend in consumption, asset holdings, and labor income. And the estimated trend deviation is used to forecast stock returns. Section 6 estimates the error correction specification for the regression of consumption on asset holdings, and labor income, in order to check the robustness of the DLS specification of the same regression, which is used by Lettau and Ludvigson (2001). Section 7 presents possible answers for the results of section 6. Section 8 discusses the robustness of the results. Section 9 concludes.

2 Stock Return Predictors

The co-movement of stock returns and business cycle implies the predictability of stock returns by variables which express the business conditions. Financial variables including dividends, stock prices, and earnings, and macroeconomic variables including the consumption-wealth ratio are documented to have the forecasting power for stock returns. This section introduces the most important methods and literature about stock return predictability. The forecasting power of the consumption-wealth ratio (Lettau and Ludvigson (2001)) is described in section (4).

2.1 Methods used for Forecasting Long-Horizon Stock Returns

There are at least two popular methods to forecast long-horizon stock returns. The first method is an OLS regression of stock returns on lagged return predictors. This method is widely used by many authors including Fama and French (1988a), Lamont (1998), Lettau and Ludvigson (2001). Defining P_t as real stock price measured at the end of period t and D_t as real dividends paid during period t, a typical OLS specification is the following,

$$r_{t\to k} = \alpha + \beta Y_t + u_{t\to k}, \tag{1}$$

where $r_t = ln((P_t + D_t)/P_{t-1})$, $r_{t\to k} = r_{t+1} + r_{t+2} + \cdots + r_{t+k}$ is the continuously compounded k-period rate of return, and Y_t is a price predictor. However, in this equation, if the data are sampled more finely than the compound return interval, then the residual, $u_{t\to k}$, is serially correlated. For example, if r_t is the quarterly return, then the residual from regression of one-year future return ($k = 4$) at time t is,

$$u_{t\to k} = r_{t+1} + r_{t+2} + r_{t+3} + r_{t+4} - \alpha - \beta Y_t. \tag{2}$$

Comparing (2) with the residual at time $t + 1$,

$$u_{t+1\to k} = r_{t+2} + r_{t+3} + r_{t+4} + r_{t+5} - \alpha - \beta Y_{t+1},$$

the residual at time t, $u_{t\to k}$, is correlated with the residual at time $t + 1$, $u_{t+1\to k}$, through the common terms, $r_{t+2} + r_{t+3} + r_{t+4}$. If there is serial correlation of the error term, then the OLS standard errors are differently distributed from OLS errors without serial correlation. Although the estimators of equation (1) are still unbiased, the covariance matrix is different from the case with independently and identically distributed error terms. Therefore, in order to have correct t-statistics for the estimators, the covariance matrix has to be corrected. Lettau and Ludvigson (2001) use the Newy-West correction to get consistent estimates of the covariance matrix in the presence of both heteroskedasticity and autocorrelation. In addition, the asymptotic distribution of the OLS estimator of equation (1) can be derived from Hansen's (1982) generalized method of moments (GMM), as mentioned by Hodrick (1992).

The second popular method for forecasting long-horizon stock returns is a one-step-ahead predication from a vector autoregression (VAR) of stock returns and return predictors, as in Campbell and Shiller (1988), Campbell (1991), Hodrick (1992), and Lettau and Ludvigson (2001). Hodrick (1992) shows that a VAR can generate implicit long-horizon statistics without actually measuring data over a long horizon. An advantage of this method is that expected returns are also allowed to vary, while expected returns are constant in the OLS regression.

2.2 Dividend Ratios as Stock Return Predictors

The predictive power of the dividend ratios is documented by many researchers. Shiller (1984), Campbell and Shiller (1988), and Fama and French (1988) show that the ratios of price to dividends or earnings have predictive power for stock returns. Lamont (1998) shows the forecasting ability of the dividend payout ratio.

2.2.1 Intuition and Properties

Why does the information about price, dividend, and earning per share help to forecast stock returns? The intuition behind it is as follows:

The level of price is usually thought to be an important measure of future stock returns, because stock prices are mean-reverting. The properties of mean-reverting of price are often interpreted as being due to the rational time-varying discount rate or irrational movements in prices. In addition, since stock prices have a slowly decaying stationary component, long-horizon returns are strongly autocorrelated, as mentioned by Fama and French (1988b). This property makes the expected long-horizon return predictable. Furthermore, there is the so called "discount-rate effect", which relates the shock to the future return with the opposite shock to the current price. If there is a positive shock in the future return, the current price decreases because of the positive shock to discount rates. In the long-run, on average, the immediate decline of the current price will offset the positive shock in the future return and keep the future stock price unchanged. This evidence is shown by Fama and French (1988a).

The level of dividend is thought to forecast stock returns, because higher dividend in this period predicts higher future returns. Furthermore, dividends can be interpreted as a measure of the permanent components of stock prices, due to managerial behavior in setting dividends, as mentioned by Lamont (1998). A higher current dividend signals an increase in the permanent components of the stock price, which implies the level of stock returns.

The level of earning forecasts stock returns, because earning is correlated with the business cycle, with which the risk premia in return is negatively correlated. In recessions, earning is low and investors need a higher expected return to offset high risks. In booms, earning is high and a low expected return is enough for investors to offset low risks. Thus, the level of earnings signals the movement of future stock returns.

By investigating the predicting ability of price, dividend, and earning, Lamont (1998) finds out that information about dividends and earnings is chiefly correlated with short-run variation in expected returns, and price is the only relevant variable which helps forecast the long-run expected returns.

2.2.2 Theoretical Explaining

In this part, the predictive ability of the dividend yield, is explained by using theoretical aspects. Considering a discrete-time model in which the dividend per share during period t, D_t, grows at a constant rate, g, and the market interest rate, r, is constant, the price of the share at time t can be defined as,

$$P_t = \frac{D_{t+1}}{1+r} + \frac{D_{t+1}(1+g)}{(1+r)^2} + \frac{D_{t+1}(1+g)^2}{(1+r)^3} \cdots = \frac{D_{t+1}}{r-g}.$$

Thus, the dividend yield can be represented as the difference between the interest rate and the dividend growth rate,

$$\frac{D_{t+1}}{P_t} = r - g,$$

where the discount rate for dividends, r, is the period-by-period return on the stock in this certainty model. This equation shows that the dividend yield is equal to the growth-adjusted stock return. This is the so called Gordon (1962) model.

A so called dynamic version of the Gordon (1962) model, is "the dividend-ratio model", which is introduced by Campbell and Shiller (1988). This model describes the dividend yield as a linear function of dividend growth rate and discount rate and has been accepted by many other researchers to investigate the predictive power of the dividend yield for stock returns.

Starting by defining the gross return on a stock held during period t, as R_t, the log gross return can be written as a function of the dividend paid during period t, D_t, and the price at the end to period t, P_t, namely

$$r_t = log(P_t + D_t) - log(P_{t-1}).$$

This equation denotes a nonlinear relationship between the log stock return, log dividend, and log price. The nonlinearity comes from the fact of taking the log of the sum of price and dividend. Campbell and Shiller (1988) show that this non-linear relation can be approximated by taking a first-order Taylor expansion. The resulting approximations show,

$$\begin{aligned} r_t &\approx k + \rho p_t + (1-\rho)d_t - p_{t-1} \\ &\approx k + (1-\rho)(d_t - p_t) + (p_t - p_{t-1}) \\ &\approx k + (d_{t-1} - p_{t-1}) - \rho(d_t - p_t) + \Delta d_t, \end{aligned} \tag{3}$$

where ρ is the steady-state ratio of price to price plus dividend, $P/(P+D)$, k is a constant and lowercase letters are the logs of the corresponding uppercase letters. Because the constant term is not essential in the analysis, k will be ignored from now on. Equation (3) defines that the log stock return is a linear function of the log dividend yield, $d_t - p_t$, and the growth rate of dividend, Δd_t. Solving this equation forward and imposing the terminal condition that $lim_{j\to\infty}(d_{t+j} - p_{t+j}) = 0$, the log dividend yield may be written as

$$d_t - p_t \simeq \sum_{j=1}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}). \tag{4}$$

Equation (4) shows that the log dividend yield can be written as a function of discounted value of all future returns and dividend growth rates. Noticing (4) holds ex post, Campbell and Shiller (1998) show that this equation can also be held ex ante,

$$d_t - p_t \simeq E_t \sum_{j=1}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}), \tag{5}$$

where E_t is the conditional expectation on the information available at time t. Equation (5) is the so called ”dividend-ratio model”, or dynamic Gordon model. In this equation, the log dividend yield reflects the growth-adjusted stock return, $r_{t+j} - \Delta d_{t+j}$. If the growth rate of dividend is stable or the growth rate of dividend is related with the stock return, then the log dividend yield can predict the movement of the stock return.

From this dividend-ratio model, a clear relation between the log dividend yield and the stock return can be obtained. Using the annual data from the Standard & Poor's Composite Stock Price Index and the monthly data from the value-weighted New York Stock Exchange (NYSE) index from 1926 to 1986, Campbell and Shiller (1988) show that the log dividend yield moves with rationally expected future growth in dividends. However, they do not find strong evidence that the log dividend yield helps forecast measured stock returns.

Table 1: **Long-Horizon OLS Regression**

This table reports OLS regressions of nominal and real CRSP value-weighted NYSE portfolio returns on dividend yields from 1927 to 1986. t-statistics are adjusted for the sample autocorrelation of overlapping residuals with the method of Hansen and Hodrick (1980). Significant coefficients at the five percent level are highlighted in bold face.

$$r_{t\to t+k} = a + b(D_t/P_t) + e_{t\to t+k}$$

Horizon k	Nominal Returns			Real Returns		
	b	t-statistic	R^2	b	t-statistic	R^2
M	0.21	1.40	0.00	0.28	1.83	0.00
Q	**1.07**	2.10	0.01	**1.26**	2.48	0.02
1Y	2.47	1.27	0.01	3.35	1.72	0.03
2Y	**7.38**	2.04	0.09	**8.77**	2.59	0.15
3Y	**9.94**	2.21	0.13	**11.53**	2.93	0.21
4Y	**12.86**	2.43	0.19	**14.43**	3.25	0.29

2.2.3 Some Pieces of Evidence

Fama and French (1988a) use the dividend yield (D/P) to forecast returns on the value- and equal-weighted portfolios of New York Sock Exchange (NYSE) stocks at forecasting horizons from one month to four years, in the sample period from 1927 to 1986. They find evidence that the dividend yield can explain more than 25% of the variances of two- to four-year stock returns, but can only explain less than 5% of the variance of monthly or quarterly returns.

As can be seen in Table (1), adopted by Fama and French (1988a), the slopes of the dividend yield are not significant at the monthly and one-year horizon, but significant at the quarterly horizon and horizons above two years. All the estimators are positive, which is consistent with the theory. If dividend is higher or current stock price is lower, the future stock return will be higher, as can be seen in equation (5). At short horizons the R^2 is small, while at long horizons from two to four years the R^2 is around and above 20%. At a four-year horizon, fast 30% of the variations in real stock returns is predictable ahead of time from the dividend yield. The results from the regression of the nominal returns and the regression of the real returns are similar. Table (1) shows that the dividend yield is a good predictor for the stock return at horizons in excess of two years and its forecasting power increases with the return horizon.

Fama and French (1988a) explain this evidence as follows: if expected returns have strong positive autocorrelation, then the variance of expected returns, which is measured by the fitted value in the regression of returns on dividend yields, grows faster than in proportion to the return horizon. In contrast to this, the variance of unexpected returns, which is measured by the residual variances for regressions of returns on dividend yields, increases less than in proportion to the return horizon, due to the discount-rate effect. The discount-rate effect shows that shocks to expected returns are correlated with opposite shocks to current prices. In the long-run, the immediate decline of current price will offset the positive shock in future returns and keep the future stock price unchanged.

Lamont (1998) explores the forecasting ability of the log dividend payout ratio $(d - e)$ for asset returns. Using quarterly data of Standard $\&$ Poor's (S&P) Composite Index from 1947 to 1994, Lamont (1998) shows that dividends and earnings help predict short-term returns, but these variables are unimportant for forecasting long-term returns. Table (2), adopted by Lamont (1998), investigates the forecasting ability of the log dividend yield and the log dividend payout ratio for one-quarter-ahead quarterly stock excess returns in an OLS regression. All the estimators are significant at the five percent level. Row 3 compares the forecasting power of the log dividend yield and the log dividend payout ratio. Putting these two dividend ratios together increases the forecasting power for both ratios. As univariate predictors, each of these two ratios can explain no more than 5% of the variation of stock returns. By putting these two ratios together, they can explain 13% of the variation of stock returns.

2.3 Relative Bill Rate as Return Predictor

The predictive power of the short-term interest rate for stock returns is documented by authors, including Fama and Schwert (1977) and Campbell (1987). The short-

Table 2: **Forecasting Quarterly Excess Returns**

This table reports OLS regressions of stock excess returns on lagged dividend yields and dividend payout ratios, with a sample period from the first quarter of 1947 to the fourth quarter of 1994. The dependent variable is quarterly log excess returns on the S&P Composite Index. $d_t - p_t$ is the log dividend yield, $d_t - e_t$ is the log dividend payout ratio. OLS standard errors are in square brackets below the coefficient estimates.

♯	Constant	$d_t - p_t$	$d_t - e_t$	R^2
1	0.222	0.064		0.05
	[0.065]	[0.020]		
2	−0.042		0.083	0.04
	[0.020]		[0.028]	
3	0.207	0.083	0.112	0.13
	[0.062]	[.020]	[0.028]	

term interest rate helps forecast stock returns, because it is correlated with business conditions. Since the level of short-term interest rate may be nonstationary over the sample period, it is stochastically detrended by a subtraction of a one-year moving average. Campbell (1991) and Hodrick (1992) document the forecasting power of the relative bill rate, which is calculated as the one-month Treasure-bill rate minus its 12-month backward moving average.

Table (3), adopted by Campbell (1991), reports the estimation of a first order VAR of the real stock return, the dividend yield and the relative bill rate, by using monthly data from the value-weighted New York Stock Exchange Index from 1952 to 1988. Row 1 shows the regression of the return on the lagged return, the lagged dividend yield, and the lagged relative bill rate. Both coefficients of the dividend yield and the relative bill rate are significant. The dividend yield and the relative bill rate can explain 6.5% of the variation of the future stock return. The negative coefficient of the relative bill rate means that if the current relative bill rate is high, implying a business boom, the one-month ahead future monthly return will be low. In addition, row 2 shows that the relative bill rate helps forecast the future dividend yield too.

Table 3: **Vector Autoregression of Real Stock Returns**

The table reports coefficient estimates from a first-order vector autoregression (VAR) of returns, dividend yields, and relative rates in the sample period from 1952 to 1988. r_t is the log real stock return over a month. D_t/P_t is the dividend yield, the ratio of total dividends paid over the previous year to the current stock price. $RREL_t$ is the one-month Treasury bill rate minus its one-year backward moving average. Standard errors, which are corrected for heteroskedasticity, appear in squared brackets below the coefficient estimates. Significant coefficients at the five percent level are highlighted in bold face.

♯	Dependent Variable	r_t	D_t/P_t	$RREL_t$	R^2
1	r_{t+1}	0.048	**0.490**	**−0.724**	0.065
		[0.060]	[0.227]	[0.192]	
2	$d_{t+1} - p_{t+1}$	−0.001	**0.980**	**0.034**	0.959
		[0.003]	[0.011]	[0.009]	
3	$RREL_{t+1}$	0.013	−0.017	**0.739**	0.548
		[0.012]	[.058]	[0.052]	

2.4 Term Spread and Default Spread as Return Predictors

The forecasting power of the term spread and the default spread is documented by Fama and French (1989). The term spread is the difference between the AAA corporate bond yield and the one-month bill rate, and the default spread is the difference between the yield on a market portfolio of corporate bonds and the yield on AAA corporate bond. If the returns on bonds are correlated with stock markets, then the variables commonly used to measure default and term premiums in bond returns can predict stock returns, and dividend yields commonly used to forecast stock returns can also predict bond returns. Using the value- and equal-weighted portfolios of New York Stock Exchange (NYSE) stocks and corporate bonds maintained by Ibbotson Associates from 1926 to 1987, Fama and French (1989) show that the term spread and the default spread help forecast stock market returns, which indicates that the expected returns on bonds and stock markets move together. Moreover, the default spread is found to be more correlated with long-term business cycles, while the term spread is more correlated with short-term business cycles.

Table (4), adopted by Fama and French (1989), reports long-horizon forecasting of stock excess returns. Row 1 shows that the slopes of the default spread are sig-

Table 4: **OLS Regression of Stock Returns**

This table reports the estimates of the OLS regression, $r_{t\to t+k} = a + bDEF_t + cTREM_t + e_{t\to t+k}$, where k is the horizon. The data are from value-weighted portfolio of New York Stock Exchange (NYSE) stocks, in the sample period from 1941 to 1987. DEF_t is the default spread and $TREM_t$ is the term spread. t-statistics, which are adjusted for the sample autocorrelation of overlapping residuals with the method of Hansen and Hodrick (1980), appear in parentheses below the coefficient estimates. Significant coefficients at the five percent level are highlighted in bold face.

♯	Horizon	1 Month	1 Quarter	1 Years	2 Years	3 Years	4 Years
1	DEF_t	0.52	2.18	**10.98**	**24.83**	**36.07**	**41.99**
		(1.43)	(1.61)	(2.12)	(3.01)	(4.17)	(3.94)
2	$TREM_t$	**0.46**	**1.09**	1.75	−0.89	−3.47	−1.60
		(3.21)	(2.03)	(0.99)	(−0.38)	(−0.96)	(−0.40)
3	R^2	0.02	0.04	0.09	0.21	0.39	0.43

nificant in excess of a one-year horizon. In contrast, row 2 shows that the slopes of the term spread are only significant at monthly and quarterly horizons. Moreover, all the slopes of the default spread are positive. And at the four-year horizon the default spread and the term spread can explain 43% of the variation of stock excess returns.

3 Consumption Theory

In this section, the main macroeconomic theory about the consumer behavior and the consumption function is presented. Because the derivation of the consumption-wealth ratio is mainly based on interpretation of the consumer behavior in macroeconomics, it is very important to introduce consumption theory before starting to talk about the consumption-wealth ratio.

3.1 Optimal Consumption under the Budget Constraint

Optimal consumption under the budget constraint is one of the key concepts of consumption theory. Households receive an income from their work, their asset holdings, transfer programs or other resources and have to decide how much to consume and how much to save. Macroeconomics give emphasis to the point in time when the households decide to consume. The households' decision about consumption has to be optimized under the budget constraint. It can be interpreted in the following simple model.

Consider a representative agent in a two-periods endowment economy. The agent consumes C_t in the first period and has income Y_t. If $Y_t - C_t$ is positive, the agent is lending; if $Y_t - C_t$ is negative, the agent is borrowing. In the second period, the agent will consume C_{t+1}, which is equal to the sum of income Y_{t+1} and the return (loss) of the lending (borrowing), $(1 + R)(Y_t - C_t)$, formally,

$$C_{t+1} = Y_{t+1} + (Y_t - C_t)(1 + R). \tag{6}$$

By dividing (6) by $(1 + R)$ and rearranging,

$$C_t + \frac{C_{t+1}}{1+R} = Y_t + \frac{Y_{t+1}}{1+R} = \Omega, \tag{7}$$

"the intertemporal budget constraint" of the representative agent is obtained. Ω denotes the total wealth of the agent, which is represented by the total income in this framework. On the budget line, the agent will spend his wealth in the course of two periods. The present value of the consumption should be equal to the present value of the income. Given this budget constraint, the agent will optimize his consumption flow according to his preference.

3.2 Form of the Aggregate Consumption Function

A standard Keynesian aggregate consumption function is usually,

$$C = c_0 + cY,$$

where Y denotes disposable income, c_0 and c are coefficients. This equation just simply defines that total consumption is a linear function of total disposable income. After the Neoclassical-Keynesian Synthesis came into being, several Neo-Keynesians tried to ground the major Keynesian relationships including consumption function in Neoclassical microeconomic theory. Specifically, they try to drive these relationships with utility-maximization.

James S. Duesenberry made the first try by putting "habit formation" in consumption behavior. Proposing that people easily increase their consumption when income increases, but they are reluctant to reduce their consumption when income decreases, Duesenberry (1949) supposed the following consumption function,

$$C = c_0 + c_1 Y + c_2 Y^M,$$

where Y^M is the peak consumption reached in the past. Therefore, consumption will increase, when income rises above the previous peak level.

Modigliani and Brumberg (1954) try to go further than Duesenberry (1949). They proposed "Life Cycle Hypothesis". A similar idea is "Permanent Income Hypothesis" which was proposed independently by Friedman (1957). The basic intuition behind it is the following. Most households do not have a constant flow of income over their lifetimes. Typically, young people earn less because of the studying time and old people earn more because of the education and experience. Therefore, under the assumption of the optimal consumption, they should borrow when they are young and repay their debts and save when they are older. According to their permanent income (their long-term expected income), people maintain a constant flow of consumption over their lifetime.

The Modigliani and Brumberg model starts by assuming a representative consumer who maximizes his utility subjected to the resources available to him. The resources are current and discounted future earnings over his lifetime and his current net worth. By assuming that the utility function is homogeneous and the individual neither expects to receive nor desires to leave any inheritance, Modigliani and Brumberg (1954) show that the aggregate consumption function has the form,

$$C_t = cV_t,$$

where V_t is the sum of net worth at time t, current income at time t and present value of all expected future income. In Friedman's (1957) version, V_t can be thought of as "permanent income". Ando and Modigliani (1963) have modified this consumption as following,

$$C_t = \alpha_1 A_{t-1} + \alpha_2 Y_t + \alpha_3 Y_t^e,$$

where C_t is the aggregate consumption, A_{t-1} is net worth, Y_t is current nonproperty income (current labor income), and Y_t^e is expected annual nonproperty income (expected annual labor income). By further assuming that current nonproperty income is a proper estimator of expected annual nonproperty income, the aggregate consumption function has the following form,

$$C_t = \alpha_1 A_{t-1} + \alpha_4 Y_t, \tag{8}$$

where α_4 is a function of α_2 and α_3. This form of aggregate consumption function is very important. The consumption-wealth ratio, which is proposed by Lettau and Ludvigson (2001), coincides with this aggregate consumption function.

3.3 Random Walk Theory of Consumption

According to the permanent income hypothesis, consumption should follow a random walk. The basic intuition is that if the future income flow is correctly anticipated, they will be incorporated into current wealth and the consumption decisions will fully reflect this information, according to the intertemporal budget constraint (7). Therefore, only the unexpected surprise in the income flow can really alter wealth and thus consumption. In other words, change in consumption must be unpredictable. This is known as the random walk theory of consumption.

Campbell and Mankiw (1989) use the simplest version of the permanent income hypothesis to formulate the random walk process of consumption. Formally, the representative consumer maximizes

$$E_t \sum_{i=0}^{\infty} (1+\delta)^{-t} U(C_{t+i}), \tag{9}$$

where C is consumption, δ is the subjective discount rate, and E_t is the conditional expectation on information available at time t. $U(C)$ is the utility function of consumption C, where $U'(C) > 0$ and $U''(C) < 0$. If the consumer can borrow and lend at the real interest rate r, then the first-order necessary condition according to consumption from equation (9) is

$$E_t U'(C_{t+1}) = (\frac{1+\delta}{1+r}) U'(C_t).$$

This equation shows that the marginal utility of today is equal to the marginal utility of tomorrow multiplied by a constant. By assuming $r = \delta$ and the marginal utility is linear, the consumption has a random walk path,

$$E_t(C_{t+1}) = C_t.$$

The optimal prediction of the consumption of tomorrow is the consumption of today. This implies that if permanent income (expected long-term income) exists and therefore the expectation about the consumption tomorrow is correct, then there is no change in consumption. If there are changes, then it should be due to some unexpected surprises. Thus,

$$\Delta C_t = \varepsilon,$$

where ε is the rational forecast error, i.e., the unexpected innovations in the permanent income. According to the permanent income hypothesis, the change in consumption is not predictable. Consumption follows a random walk.

3.4 Wealth or Current Income?

Should consumption be more correlated with income or with wealth? According to a forward-looking consumer model, consumption should be correlated with wealth, which implies the present value of all future income. The available measure of wealth includes financial assets, financial liabilities, fixed assets, and real estate of a household. As represented in the optimal consumption under the intertemporal budget constraint and in the permanent income hypothesis, a consumer will try to smooth his consumption flow in his lifetime according to his total income flow, presented by the current wealth, but not the current income. Thus, wealth should be the correct measure of the consumption flow. However, an old tradition in macroeconomics is to relate aggregate consumption with current disposable income. Disposable income of households, which is roughly equal to GDP less net taxes, is what households actually receive to spend or save. Households set part of the personal disposable income aside for saving and consume the rest, through which consumption is correlated with disposable income.

In order to find the consumption behavior in practice, Campbell and Mankiw (1989) represent a model with two groups of consumers. Half the consumers are forward-looking and consume their permanent income, which presents the wealth level. Half the consumers follow the ”rule of thumb” and consume their current income. Based on this model, Campbell and Mankiw (1989) find strong evidence to state that the expected changes in current income are associated with expected changes in consumption. This shows that consumption should not follow a random walk and the consumption growth is predictable.

Under the motivation of the predictability of consumption growth, Campbell and Mankiw (1989) construct the consumption-wealth ratio, in order to determine the absolute level of consumption given either wealth and expected future interest rates, or expected future income flows and interest rates. Based on this framework of the consumption-wealth ratio, Lettau and Ludvigson (2001) began their analysis about the predictive power of the consumption-wealth ratio for the asset returns.

4 The Consumption-Wealth Ratio with U.S. Data

This section introduces the derivation of the consumption-wealth ratio made by Campbell and Mankiw (1989), the interpretation of the consumption-wealth ratio made by Lettau and Ludvigson (2001), and the forecasting power of fluctuations in the consumption-wealth ratio for stock returns, introduced by Lettau and Ludvigson (2001).

4.1 The Model

Consider the intertemporal budget constraint of a consumer who invests his wealth in a single asset with a time-varing risky return. In this representative agent economy all wealth, including human capital, is tradable. Income (including labor income) does not appear explicitly at this stage because all the consumer's income flows are capitalized into marketable wealth. The two-period budget constraint is,

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t), \tag{10}$$

where W_t denotes the aggregate wealth in period t and $R_{w,t+1}$ is the net return on the invested aggregate wealth. The invested aggregate wealth is the subtraction of consumption C_t from the aggregate wealth. Equation (10) is nonlinear because of the interaction between subtraction and multiplication. Consumption is first subtracted from the aggregate wealth to get the invested wealth, and invested wealth is then multiplied by the return to have the next period's wealth. To linearize equation (10) and get the consumption-wealth ratio, Campbell and Mankiw (1989) have taken the following three steps.

Firstly, they divide equation (10) by W_t, and take logs. The resulting equation is,

$$w_{t+1} - w_t \quad = \quad r_{w,t+1} + log(1 - exp(c_t - w_t)), \tag{11}$$

where $r_{w,t+1} = log(1 + R_{w,t+1})$, and the lowercase letters are used to denote the logs of the corresponding upper-case letters throughout. Note that the last part of the equation (11) is still a nonlinear function of the log consumption-wealth ratio, $c_t - w_t = x_t$.

Secondly, they take a first-order Taylor approximation of the function, $log(1 - exp(x_t))$, around the point $x_t = x$. The resulting approximation is,

$$log(1 - exp(c_t - w_t)) \quad \approx \quad k + (1 - 1/\rho_w)(c_t - w_t), \tag{12}$$

where the parameter $\rho_w = 1 - exp(x)$, which can also be interpreted as the steady-state ratio of the new investment to total wealth, $(W - C)/W$. The constant term $k = log(\rho_w) - (1 - 1/\rho_w)log(1 - \rho)$. By substituting (12) in (11), they obtain

$$\Delta w_{t+1} \quad \approx \quad k + r_{w,t+1} + (1 - 1/\rho_w)(c_t - w_t). \tag{13}$$

This equation shows that the growth rate of the aggregate wealth is a linear function of the log return on wealth and the log consumption-wealth ratio.

Finally, solving (13) forward and imposing that $lim_{i \to \infty} \rho_w^i (c_{t+i} - w_{t+i}) = 0$, the log consumption-wealth ratio is obtained,

$$c_t - w_t = \sum_{i=1}^{\infty} \rho_w^i (r_{w,t+i} - \Delta c_{t+i}) + \rho k/(1 - \rho). \tag{14}$$

Equation (14) is a log-linear version of the infinite-horizon budget constraint and holds ex post. It shows that the log consumption-wealth ratio of today is associated with the future rate of return on invested wealth and future consumption growth. Combining (14) with the log-linear Euler equation, Campbell and Mankiw (1989) show that consumption is a function of wealth and the expected present value of the future rate of return.

Based on equation (14), Lettau and Ludvigson (2001) treat the consumption-wealth ratio as the predictor for either return on asset or consumption growth, or both. Three further developments of the consumption-wealth ratio have been made by them.

First, Lettau and Ludvigson assume that equation (14) can be held ex ante with a forward-looking consumer. The log consumption-wealth ratio can be written as,

$$c_t - w_t = E_t \sum_{i=1}^{\infty} \rho_w^i (r_{w,t+i} - \Delta c_{t+i}), \tag{15}$$

where the constant term is omitted because it does not play a role in the analysis. E_t is the conditional expectation on information available at time t. Equation (15) shows that the log consumption-wealth ratio can predict either the expected returns to the total wealth (market portfolio) or the expected consumption growth, or both. In addition, the consumption-wealth ratio can only vary if consumption growth or returns or both are predictable. Based on this view, the consumption-wealth ratio has confirmed the two important developments in finance and macroeconomics, i.e. the predictability of stock returns and the predictability of consumption growth.

Second, Lettau and Ludvigson assume that the wealth W is the sum of asset holdings A and human capital H, $W_t = A_t + H_t$. The log aggregate wealth may be represented as,

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

where ω is the average ratio of asset holdings to total wealth, A/W. Denoting R_a as the net return on the asset holdings and R_h as the net return on human capital, the gross return on aggregate wealth can be written as,

$$1 + R_{w,t} = \omega_t(1 + R_{a,t}) + (1 - \omega_t)(1 + R_{h,t}). \tag{16}$$

Campbell (1996) shows that equation (16) can be transformed into a log version,

$$r_{w,t} \approx \omega r_{a,t} + (1 - \omega)r_{h,t}, \tag{17}$$

which can be obtained by denoting $r_t = log(1 + R_t) \approx R_t$ and linearizing around the mean of ω_t. Substituting (17) into the budget constraint (15) gives,

$$c_t - \omega a_t - (1 - \omega)h_t = E_t \sum_{i=1}^{\infty} \rho_w^i \{[\omega r_{a,t+i} + (1 - \omega)r_{h,t+i}] - \Delta c_{t+i}\}. \tag{18}$$

Note that the human capital, h_t, is not observable in equation (18).

Third, Lettau and Ludvigson assume that observable aggregate labor income, Y_t, can describe the unobservable human capital, H_t. Thus,

$$h_t = \kappa + y_t + z_t, \tag{19}$$

where κ is a constant and z_t is a mean zero stationary random variable. Substituting (19) into equation (18) and ignoring the constant term, the log consumption-wealth ratio can be described with only observable variables,

$$c_t - \omega a_t - (1 - \omega)y_t = E_t \sum_{i=1}^{\infty} \rho_w^i \{[\omega r_{a,t+i} + (1 - \omega)r_{h,t+i}] - \Delta c_{t+i}\} + (1 - \omega)z_t. \tag{20}$$

This is the final version of the log consumption-wealth ratio described by Lettau and Ludvigson (2001). Because all the variables on the right-hand side of (20) are presumed stationary and all the variables on the left-hand side have normally a unit root, the variables on the left-hand side, c, a, and y must be cointegrated. The deviation from the common trend, $c_t - \omega a_t - (1-\omega)y_t$, is denoted as cay_t. Equation (20) shows that trend deviation cay_t is a function of the expected return on assets, the expected return on human capital, and the expected consumption growth rate. In addition, if the expected return on human capital, $r_{h,t+i}$, and the expected consumption growth, Δc_{t+i}, are not too volatile or these variables are strongly correlated with the expected return on asset, $r_{a,t+i}$, then the cay_t can predict the expected return on future assets.

It is instructive to compare (20) with the consumption function (8) included in Ando and Modigliani (1963),

$$C_t = \alpha_1 A_{t-1} + \alpha_4 Y_t,$$

where C_t is the consumption, A_{t-1} is the net worth, and Y_t is the labor income. Because the right-hand side of equation (20) is stationary, the left-hand side of (20) actually determines the equilibrium relation between log consumption, log asset holdings (log household net worth), and log labor income. Thus, this relation is a log version of the consumption function in Ando and Modigliani (1963) based on the life-cycle hypothesis.

Moreover, comparing (15) with the log dividend-price ratio in equation (5),

$$d_t - p_t \simeq E_t \sum_{j=1}^{\infty} \rho^j (r_{t+j} - \Delta d_{t+j}),$$

shows that there is some similarity between these two equations. Both equations hold ex post and ex ante. Both ratios, the consumption-wealth ratio and the dividend-price ratio, reflect some growth adjusted returns. The role of consumption in equation (15) is analogous to the role of dividend in equation (5). In an exchange economy without labor income, the consumption is equal to dividends and the consumption-wealth ratio is a transformation of the dividend-price ratio. This is the so called Lucas Tree model, in which stocks are claims to consumption.

One imagines that fruits (dividends) fall from trees (firms) and are consumed, and that nothing else happens in the economy. Hence, consumption is thought to be the dividend paid from aggregate wealth.

4.2 The Estimation

According to equation (20), there is a linear combination of consumption, asset holdings and labor income. This combination is stationary. This section introduces the estimation of the parameters of the shared trend in consumption, asset holdings, and labor income with U.S. quarterly data from 1952 to 1998, included in Lettau and Ludvigson (2001).

For the estimation, Lettau and Ludvigson adjust the log consumption-aggregate wealth ratio according to the tradition of using nondurables and services as a measure of consumption in empirical work. They assume that log consumption is a constant multiple of log nondurables and services, $c_t = \lambda c_{n,t}$, where $c_{n,t}$ denotes log nondurable consumption and $\lambda > 1$. The log consumption-aggregate wealth ratio is transformed to the log nondurable consumption-aggregate wealth ratio,

$$\begin{aligned} c_{n,t} - \beta_a a_t - \beta_y y_t &= (1/\lambda) E_t \sum_{i=1}^{\infty} \rho_w^i \{[\omega r_{a,t+i} + (1-\omega) r_{h,t+i}] - \Delta c_{t+i}\} \\ &\quad + (1/\lambda)(1-\omega) z_t, \end{aligned}$$

where $\beta_a = (1/\lambda)\omega$ and $\beta_y = (1/\lambda)(1-\omega)$. $\beta_a + \beta_y$ identifies $1/\lambda$.

In addition, there is evidence supporting the view that nondurable consumption, labor income, and household net worth (measure of asset holdings by Lettau and Ludvigson) all contain a unit root and there is a single cointegrating vector for these three variables. Lettau and Ludvigson (2001) use a dynamic least squares (DLS) technique proposed by Stock and Watson (1993), to estimate the cointegrating vector. The equation with the DLS specification has the following form,

$$c_{n,t} = \alpha + \beta_a a_t + \beta_y y_t + \sum_{i=-k}^{k} b_{a,i} \Delta a_{t-i} + \sum_{i=-k}^{k} b_{y,i} \Delta y_{t-i} + \epsilon_t, \tag{21}$$

where Δ is the first difference operator. The DLS specification - which is used to eliminate the effects of regressor endogeneity on the distribution of the least squares estimator - regresses one of the variables onto contemporaneous levels of the remaining variables, leads and lags of their first differences, and a constant. Equation (21) is estimated by Standard OLS, which provides consistent estimates of the cointegrating parameters, although the error term ϵ_t is typically correlated with the regressors, a_t and y_t. These "superconsistent" OLS estimates of cointergrating parameters are due to the fact that the estimators converge to the true parameter values at a rate proportional to the sample size T rather than proportional to $\sqrt{T}$ as in ordinary applications (Stock (1987)).

Using U.S. data from the fourth quarter of 1952 to the third quarter of 1998, Lettau and Ludvigson (2001) obtain the following estimates of equation (21),

$$\begin{array}{rccccc} c_{n,t} = & 0.61 & + & 0.31a_t & + & 0.59y_t\ , \\ & (7.96) & & (11.70) & & (23.92) \end{array} \tag{22}$$

where the corrected t-statistics appear in parentheses below the estimators of coefficients and the coefficient estimates on the first differences are ignored. The coefficient estimates imply that the share of asset holding in aggregate wealth is close to one-third, while the share of human capital in aggregate wealth is close to two-thirds. In addition, through a vector autoregression (VAR) of consumption growth, assets growth, and labor income growth with lagged estimated trend deviation, $\widehat{cay}_t = c_{n,t} - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, as the exogenous variable, Lettau and Ludvigson show that $\widehat{cay}_t$ predicts the asset growth significantly, but not consumption growth and labor income growth. Hence, deviations from the shared trend in consumption, asset holdings, and labor income are better described as transitory movements in asset holdings than as transitory movements in the other two variables.

4.3 The Forecasting Results

Using the estimated trend deviation, $\widehat{cay_t} = c_{n,t} - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, Lettau and Ludvigson (2001) find out that the fluctuation in the log consumption-wealth ratio, cay_t, is a strong predictor for both one-quarter-ahead real stock returns and one-quarter-ahead excess returns over a Treasury bill rate. As can be seen in rows 1 and 2 of Table (5), all the coefficient estimators of $\widehat{cay_t}$ in the regressions of stock returns are

Table 5: **Forecasting Quarterly Stock Returns**

The table reports the estimates from OLS regressions of log stock returns on a constant, lag of the return, and the following lagged variables: the trend deviation, $\widehat{cay}_t$; the log dividend yield, $d_t - p_t$; the log dividend payout ratio, $d_t - e_t$; the relative bill rate, $RREL_t$; the term spread, $TERM_t$, the difference between 10-year Treasury bond yield and the 3-month Treasury bond yield; the default spread, DEF_t, the difference between the BAA Corporate Bond rate and the AAA Corporate Bond rate. r_t is the stock return, and $r_t - r_{f,t}$ is the excess return. In the parentheses below the coefficient estimates are the Newey-West corrected t-statistics. Significant coefficients at the five percent level are highlighted in bold face.

♯	Returns	constant	lag	$\widehat{cay}_t$	$d_t - p_t$	$d_t - e_t$	$RREL_t$	$TERM_t$	DEF_t	$\overline{R}^2$
1	r_t	**0.029**		**2.220**						0.09
		(4.672)		(3.024)						
2	$r_t - r_{f,t}$	**0.024**		**2.165**						0.09
		(4.328)		(3.226)						
3	$r_t - r_{f,t}$	0.038	0.004	**1.906**	0.011	−0.004	**−1.377**	−0.082	−0.883	0.10
		(0.278)	(−0.065)	(3.197)	(0.095)	(0.270)	(−2.443)	(−0.125)	(−0.543)	

significant. $\widehat{cay}_t$ forecasts both the stock real return and the excess return on the S&P 500 index with the adjusted R^2 of 0.09. Row 3 shows that $\widehat{cay}_t$ plays a more important role in the prediction of excess returns than other return predictors.

Furthermore, $\widehat{cay}_t$ is a strong predictor for the excess returns at short and intermediate horizons, as can be seen in Table (6). At a one-year horizon, both the estimated trend deviation and the relative bill rate have significant predictive power for excess returns. The adjusted R^2 statistics are 0.18 and 0.10 respectively, as can be seen in rows 1 and row 3. Row 4 shows that these two variables are more important in forecasting returns at a one-year horizon than the dividend yield and the dividend payout ratio. When including $\widehat{cay}_t$ and $RREL_t$ in the regression of dividend ratios, they cut the coefficient of dividend ratios in half. However, at the six-years horizon, the dividend ratios have the strongest predictability power, with adjusted R^2 statistic of 0.39 in row 6. It is their turn to cut down the coefficients of the trend deviation and the relative bill rate in row 8. This implies that the dividend ratios have a stronger forecasting power at long horizons, while the trend deviation and the relative bill rate have stronger forecasting powers at short to intermediate horizons. This evidence could be due to the fact that the dividend yield is more persistent than the trend deviation in the consumption-wealth ratio and the

Table 6: **Long-Horizon Return Forecasts**

This table reports results from long-horizon regressions of log excess returns on lagged variables: the estimated trend deviation, $\widehat{cay}_t$; the log dividend yield, $d_t - p_t$; the log dividend payout ratio, $d_t - e_t$; the relative bill rate, $RREL_t$. In the parentheses below the coefficient estimate is the Newey-West corrected t-statistics. Significant coefficients at the five percent level are highlighted in bold face.

♯	Horizons	$\widehat{cay}$	$d_t - p_t$	$d_t - e_t$	$RREL_t$	$\overline{R}^2$
1	1 year	**6.72**				0.18
		(3.70)				
2	1 year		0.14	0.08		0.04
			(1.16)	(0.70)		
3	1 year				**−4.51**	0.10
					(−2.67)	
4	1 year	**5.37**	0.07	−0.05	**−3.82**	0.23
		(3.25)	(0.67)	(−0.64)	(−2.57)	
5	6 years	**12.44**				0.16
		(3.41)				
6	6 years		**0.95**	**0.68**		0.39
			(5.27)	(3.51)		
7	6 years				−5.10	0.03
					(−1.51)	
8	6 years	**5.90**	**0.85**	**0.65**	1.36	0.42
		(1.91)	(4.95)	(2.86)	(0.48)	

relative bill rate. It becomes more important with long horizons.

To conclude, using U.S. data from the fourth quarter of 1952 to the third quarter of 1998, Lettau and Ludvigson (2001) find out that the fluctuation in the log consumption-wealth ratio is a good predictor for the stock market return over short and intermediate horizons and the log consumption-wealth ratio is the best univariate predictor of stock market excess returns for horizons up to one year.

5 The Consumption-Wealth Ratio with German Data

In this section, I use the German quarterly data to estimate the fluctuations in the consumption-wealth ratio. The forecasting power of the estimated trend deviation in consumption, assets holdings, and labor income for stock returns is investigated.

5.1 Data Construction

The first obstacle, which has to be overcome in the German data analysis, is to search for the suitable quarterly time series from all possible sources. Because not all data can be found directly, important unavailable data have to be constructed based on other available variables. This subsection presents the data sources and data construction.

5.1.1 Macroeconomic Variables

This part presents the data construction of consumption, C_t, asset holding, A_t, and labor income, Y_t. All data are quarterly, seasonally adjusted*, per capita variables, measured in 2000 euros.

Consumption

Quarterly data of private household consumption from 1970 to 2002 are obtained from the Federal Statistical Office Germany. To construct the consumption data, I make two important adjustments. First, because Lettau and Ludvigson (2001) use nondurables and services excluding shoes and clothing as the measure of consumption, I choose the following six terms in the German private household consumption to construct the comparable nondurables and services data: food, drink, and tobacco; housing, water, electricity, gas and other fuels; transportation and telecommunication; free time, entertainment, and culture; accommodation (lodging) and catering services; medical care and others. Second, because the consumption data contain two separated sets of consumption data - consumption in West Germany from the first quarter of 1970 to the last quarter of 1991 and

*Using standard US Bureau of Census methods of seasonal adjustment: X11-multiplicative consumption in unified Germany from the first quarter of 1990 to the last quarter of 2002 - I construct a set of continuous consumption data for the unification. From the first quarter of 1970 to the last quarter of 1990 the numbers from West Germany are retained, and the data in unified Germany from the first quarter of 1991 to last quarter of 2002 are spliced with the West German data before 1991 using the growth rate of the unified Germany.

Asset Holdings

Lettau and Ludvigson (2001) use household net worth as the measure of asset holdings. After struggling for a long time, I found out that there is no way to get the quarterly time series of German household net worth directly. Net worth is defined as non-financial and financial assets minus liabilities. The Organization for Economic Cooperation and Development (OECD) only supplies annual data of German household net worth from 1990 to 2001. The Deutsche Bundesbank has only the annual data of net financial assets from 1950 to 2002. And the Federal Statistical Office Germany only supplies the annual data of non-financial assets for the whole economy including private households, government, and business sector. Besides, these non-financial assets include only privately owned dwellings (house-property) from the private households, but not other non-financial assets of households.

However, I can construct quarterly data of German household net worth from the following four time series: annual data of German household net worth from 1991 to 2001 obtained from Datastream, monthly data of deposits of resident individuals at banks (MFIs) in Germany from 1970 to 2003 obtained from the Deutsche Bundesbank [†], monthly data of share capital for the whole German market from 1960 to 2003 obtained from Datastream, annual data of non-financial assets for the whole German economy from 1960 to 1997 obtained from the Federal Statistical Office Germany.

The basic idea is to regress the available short time series of net worth on the

[†] Private deposits include private transferable deposits, private time deposits, private savings deposits, and private savings certificates.

other three time series and then use the estimated coefficients and the other three time series to construct enough long quarterly time series of net worth. In addition, I regress the net worth on deposits, share, and non-financial assets at a quarterly frequency, but not at the original annual frequency of available net worth. Because the available annual data of net worth are only from 1991 to 2001, there are only ten observations in the regression of annual net worth and the estimates from this OLS regression can not be very helpful. Thus, annual data of net worth and non-financial assets and monthly data of private deposits and share capital are transformed into quarterly data, in order to improve the efficiency of the estimation.

The annual data of non-financial assets are the average of the beginning of the year and the end of the year, while all other variables are taken at the end of their periods. Therefore, all data have to be transformed into the data at the end of the period at first. And then, the annual data are expanded to quarterly data using constant growth rate and the monthly data are transformed to quarterly data using the observations of the last month of the quarter. Moreover, because Lettau and Ludvigson (2001) use the net worth variable at the beginning of the period, all the transformed quarterly data at the end of this period are treated as the beginning variables at the next period, in order to construct comparable variables.

Estimating the regression of household net worth on deposits, shares, and non-financial assets with German data from the first quarter of 1992 to the first quarter of 2002 generates the following OLS estimates,

$$\begin{array}{rccccc} w_t = & 2.44 & + 0.26 d_t & + 0.18 s_t & + 0.38 n_t\,, \\ & (3.42) & (4.13) & (3.40) & (2.84) \end{array} \tag{23}$$

where w_t denotes the household net worth, d_t denotes the private deposits, s_t is the share capital, and n_t is the non-financial assets. The data used for this estimation are quarterly, seasonally adjusted, per capital variables in logarithm, measured in 2000 euros. t-statistics appear in parentheses below the coefficient estimates. The corresponding R^2 statistic is 0.97. A time trend is not included in the equation, because if it was included, the t-statistic of the trend term would be tiny, thus not being significant. Using estimators in equation (23) and quarterly data of private deposits, shares, and non-financial assets, quarterly data of household net worth from the first quarter of 1971 to the last quarter of 2002 are obtained.

Moreover, I use the private deposits from the first quarter of 1971 to the last quarter of 2002 as the second measure of the asset holdings since cumulated saving is also used as a measure of the German wealth by some authors like Hassler (2001). Let $a_{1,t}$ denote log household net worth and $a_{2,t}$ denote log private deposits.

Labor Income

Quarterly data of labor income from 1970 to 2002 is obtained from the Federal Statistical Office Germany. Since Lettau and Ludvigson (2001) use wages and salaries plus transfer payments plus other labor income minus personal contributions for social insurance minus taxes as the measure of labor income, I choose wages and salaries (including other labor income) minus personal contributions for social insurance minus taxes as comparable German data of labor income. Besides, since these German data contain two separated labor income series - labor income in West Germany from the first quarter of 1970 to the last quarter of 1991 and labor income in unified Germany from the first quarter of 1990 to the last quarter of 2002 - I construct a continuous set of labor income data for the unification. From the first quarter of 1970 to the last quarter of 1990 the numbers from West Germany are retained, and the data in unified Germany from the first quarter of 1991 to last quarter of 2002 are spliced with the West German data before 1991 using the growth rate of the unified Germany.

5.1.2 Financial Variables

The data of stock returns, the dividend yield, the relative bill rate, and the term spread can be found and are used as return predictors in the analysis.

Quarterly data of dividend per share are calculated from the monthly data of Morgan Stanley Capital International (MSCI) German stock price index, PI, and MSCI German stock return index, RI. Dividend for each month is calculated as $D_t = ((RI_t/RI_{t-1})/(PI_t/PI_{t-1}) - 1) * PI_t$, where D_t denotes the level of dividend.

Quarterly dividend is the sum of the dividends for the three months comprising the quarter. And the dividends are multiplied by 1.5625 because of tax credits available to domestic investors.

The quarterly stock return is calculated as $R_t = (D_t + PI_t)/PI_{t-1} - 1$, where R_t denotes the stock return. Let r_t denote the log real return of the index under consideration and $r_{f,t}$ denote the log real return on the German call money rate (the "risk free rate") obtained from the IMF's International Financial Statistics CD-ROM. Thus, the log excess return is obtained by $r_t - r_{f,t}$.

The Dividend yield is calculated as the natural logarithm of dividends over the past year minus the natural logarithm of current stock price, $d_t - p_t = log(D_t + D_{t-1} + D_{t-2} + D_{t-3}) - log(PI_t)$, where d_t denotes the log dividends and p_t denotes the log stock price.

The relative bill rate, $RREL_t$, is calculated as the call money rate, $r_{f,t}$, minus its 12-month backward moving average. And the term spread, $TREM_t$, is calculated as yield on federal securities (9 to 10+ years) obtained from Datastream minus three-month interbank deposit rate obtained from IMF's International Financial Statistics CD-ROM.

5.2 Estimation of the Consumption-Wealth Ratio

5.2.1 Unit Root and Cointegration Test of Consumption, Asset Holdings, and Labor Income

The basic findings of the consumption-wealth ratio in equation (20) is that consumption, asset holdings, and labor income must be co-integrated and the deviation from the share trend is stationary. This is the fundament for the analysis about the consumption-wealth ratio. Therefore, this relation has to be checked at first before any other analysis can be conducted.

Table (7) reports the augmented Dickey-Fuller test for consumption, asset holdings, and labor income. For the variable asset holdings, both measures, household net worth and private deposits, are included. The number of lagged differences is determined according to the Akaike Information Criterion. As can be seen in Table

Table 7: **Augmented Dickey-Fuller Test for Unit Root**

This table reports the augmented Dickey-Fuller test statistic for the variables: consumption, c_t, household net worth, $a_{1,t}$, private deposits, $a_{2,t}$, and labor income y_t. For consumption and labor income, an intercept is included. For private deposits and household net worth, both an intercept and a time trend are included. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

♯	Variable	lag	Test Statistic	5% Critical Value	10% Critical Value
1	c_t	5	-1.18	-2.86	-2.57
2	$a_{1,t}$	2	-2.95	-3.41	-3.13
3	$a_{2,t}$	1	-2.04	-3.41	-3.13
4	y_t	5	-1.23	-2.86	-2.57

(7), all the values of the test statistic are larger than the corresponding 5% and 10% critical values. Therefore, the null hypothesis of unit root is accepted for all four variables.

Table (8) reports results of the cointegration test for consumption, asset holdings, and labor income, where both measures of asset holdings, household net worth and private deposits, are included. Because the Akaike Information Criterion always suggests 2 lags as the optimal number of lags, while the Schwarz Criterion always suggests 1 lag as the optimal number of lags, both optimal numbers of lags are included. As can be seen in Table (8), null hypothesis of rank 0 is rejected for all the cases, whereas null hypothesis of rank 1 is accepted for all the cases because of the smaller test statistics compared to both 90% and 95% critic values.

To summarize, there is strong evidence in the German quarterly data from 1971 to 2002 supporting the null hypothesis that consumption, asset holdings, and labor income each contains a unit root and they have a single cointegrating vector. The fundamental assumption of the consumption-wealth ratio is confirmed.

5.2.2 Estimation of Trend Deviation cay_t

The estimation of the trend relationship among consumption, labor income, and asset holdings is conducted here. Implementing the equation (21) using German data from the first quarter of 1971 to the last quarter of 2002 generates the point

Table 8: **Johansen Trace Test for Cointegration**

This table reports the results of the Johansen trace test for consumption, c_t, asset holdings, $a_{1,t}$ or $a_{2,t}$, and labor income y_t, where $a_{1,t}$ denotes household net worth and $a_{2,t}$ denotes private deposits. An intercept is included in the test. ”Test statistic” gives the value of the Likelyhood Ratio (LR) test. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

	H_0: $r =$	Test Statistic	90% Critical Value	95% Critical Value
		For c_t, $a_{1,t}$, and y_t, with Lag = 1		
1	0	152.98	31.88	34.80
2	1	13.08	17.79	19.99
3	2	3.47	7.50	9.13
		For c_t, $a_{1,t}$, and y_t, with Lag = 2		
4	0	65.41	31.88	34.80
5	1	12.58	17.79	19.99
6	2	2.97	7.50	9.13
		For c_t, $a_{2,t}$, and y_t, with Lag = 1		
7	0	88.16	31.88	34.80
8	1	14.51	17.79	19.99
9	2	4.11	7.50	9.13
		For c_t, $a_{2,t}$, and y_t, with Lag = 2		
10	0	57.87	31.88	34.80
11	1	14.50	17.79	19.99
12	2	3.87	7.50	9.13

Table 9: **Estimating the Consumption-Wealth Ratio**

This table reports OLS estimators from regression of log consumption on log wealth, log labor income, and leads and lags of the first difference of log wealth and log labor income, according to equation (21). The coefficient estimates on the first differences are ignored. k is the number of lead/lag lengths of the first differences. AIC gives the value of Akaike Information Criterion. Newy-West corrected t-statistics appear in the parentheses below the coefficient estimate. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

♯	k	constant	$a_{1,t}$	$a_{2,t}$	y_t	AIC	R^2	Durbin-Watson
1	4	-3.83	0.92		0.30	-8.10	0.99	0.37
		(-45.62)	(28.98)		(3.98)			
2	19	-0.50		0.46	0.56	-9.47	1.00	1.53
		(-1.17)		(4.02)	(1.67)			

estimates in Table (9).

Row 1 reports the estimates with household net worth as the measure of asset holdings, while row 2 reports the estimates with private deposits as the measure of asset holdings. k, the lead/lag lengths in estimating the DLS specification, is determined according to the Akaike Information Criterion (AIC). All the estimates are significant at the five percent level, except the estimator of y_t in row 2, which is significant at the ten percent level. In row 1, there are big positive autocorrelations in the residuals according to the Durbin-Watson statistic, 0.37. In row 2, with a lead/lag length of 19, OLS estimation gives a better Durbin-Watson Statistic, 1.53. According to these two estimation results, corresponding trend deviation, $\widehat{cay_t}$, can be calculated, where $\widehat{cay}_{1,t} = c_{n,t} - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$ and $\widehat{cay}_{2,t} = c_{n,t} - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$. Note that, compared with the results of Lettau and Ludvigson (2001) in equation (22), the share of asset holdings in aggregated wealth in German data is much higher and the sum of the coefficients of wealth and labor income is bigger than 1.

Furthermore, in order to interpret deviations from the shared trend in consumption, labor income, and assets, it is helpful to examine these three variables in a cointegrated vector autoregression (VAR), as included by Lettau and Ludvigson (2001). In this vector autoregression, log difference in consumption, asset holdings,

Table 10: **Estimating A Cointegrated VAR**

This table reports the sum of estimated coefficients from cointegrated vector autoregressions (VAR) of the row variable on the column variable. c_t denotes consumption. $a_{1,t}$ is household net worth. $a_{2,t}$ is the private deposit. y_t is labor income. $\widehat{cay}_{1,t}$ is $c_t - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$ and $\widehat{cay}_{2,t}$ is $c_t - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$. t-statistics appear in the parentheses below the coefficient estimate. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the fourth quarter of 1971 to the fourth quarter of 2002.

♯	Dependent variable	$\Delta c_{t-i,i=1,2}$	$\Delta a_{1,t-i,i=1,2}$	$\Delta y_{t-i,i=1,2}$	$\widehat{cay}_{1,t-1}$	$\overline{R}^2$
			Panel A			
1	Δc_t	-0.239	0.406	0.096	$\mathbf{-0.001}$	0.03
		(-1.69)	(1.60)	(0.99)	(-2.45)	
2	$\Delta a_{1,t}$	0.097	0.217	**0.129**	$\mathbf{-0.001}$	0.13
		(1.54)	(1.92)	(3.00)	(-4.77)	
3	Δy_t	0.132	0.656	-0.100	0.001	0.02
		(0.68)	(1.87)	(-0.74)	(0.85)	
			Panel B			
	Dependent variable	$\Delta c_{t-i,i=1,2}$	$\Delta a_{2,t-i,i=1,2}$	$\Delta y_{t-i,i=1,2}$	$\widehat{cay}_{2,t-1}$	$\overline{R}^2$
4	Δc_t	-0.247	0.143	0.091	$\mathbf{-0.011}$	0.04
		(-1.78)	(1.76)	(0.94)	(-4.30)	
5	$\Delta a_{2,t}$	0.176	0.210	**0.463**	$\mathbf{-0.010}$	0.12
		(0.90)	(1.82)	(3.4)	(-2.75)	
6	Δy_t	0.131	0.196	-0.104	0.000	0.00
		(0.67)	(1.71)	(-0.77)	(0.00)	

and labor income are each regressed on their own lags and an ”error-correction term”, equal to the lagged value of the estimated trend deviation, $\widehat{cay}_{t-1}$. Table (10) presents the results with a two-lag VAR. The lag number is determined according to the AIC criterion. Panel A uses household net worth as the measure of asset holdings, and Panel B uses private deposits as the measure of asset holdings.

First, rows 1, 2, 4, and 5 show that no matter which measure is used to construct assets and the corresponding trend deviation, the estimated trend deviation has some statistically significant effects on both asset growth and consumption growth. In contrast, Lettau and Ludvigson (2001) show that deviations from the shared trend can only predict the asset growth. Second, rows 2 and 5 show that lags of labor income growth helps predict the asset growth, which implies that growth of

Table 11: **Summary Statistics**

$r_t - r_{f,t}$ denotes quarterly log excess returns on the MSCI index. $d_t - p_t$ denotes the log dividend yield. $RREL_t$ is the relative bill rate and $TERM_t$ is the term spread. $\widehat{cay}_{1,t}$ is $c_t - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$ and $\widehat{cay}_{2,t}$ is $c_t - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

	$r_t - r_{f,t}$	$d_t - p_t$	$RREL_t$	$TERM_t$	$\widehat{cay}_{1,t}$	$\widehat{cay}_{2,t}$
Panel A: Correlation Matrix						
$r_t - r_{f,t}$	1.00	-0.22	-0.16	0.17	0.17	0.05
$d_t - p_t$		1.00	0.05	-0.17	-0.01	-0.34
$RREL_t$			1.00	-0.49	0.06	-0.07
$TREM_t$				1.00	0.02	0.23
$\widehat{cay}_{1,t}$					1.00	0.46
$\widehat{cay}_{2,t}$						1.00
Panel B: Univariate Summary Statistics						
Mean	0.009	-3.246	0.000	0.011	-3.823	-0.511
Standard eror	0.114	0.398	0.014	0.017	0.018	0.039
Autocorrelation	0.041	0.949	0.754	0.890	0.830	0.943

labor income is a very important factor for the asset growth. This result is also different from the findings of Lettau and Ludvigson (2001), that growth of labor income has no predictive power for any other variables. Finally, the asset growth regressions have the highest adjusted R^2, 0.12 and 0.13, which implies that asset growth is better interpreted than consumption growth and labor income growth in this VAR system.

These results suggest that the deviations from the shared trend are better interpreted as some transitory movements in asset wealth and consumption than as transitory movements in labor income.

5.2.3 Summary Statistics

After the estimated trend deviations, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, are obtained, all the necessary variables for the analysis of stock return predictability are at hand. Before forecasting stock returns, summary statistics of relevant variables are described here.

First, according to the autocorrelations in Panel B of Table (11), $\widehat{cay}_{2,t}$ is nearly as persistent as the dividend yield, while $\widehat{cay}_{1,t}$ has substantially lower autocorrelation, 0.83. And the relative bill rate has the smallest autocorrelation. Since a high autocorrelation implies a close correlation with long term business cycle, the dividend yield and $cay_{2,t}$ are supposed to forecast stock returns at a long-horizon, while the relative bill rate, $\widehat{cay}_{1,t}$, and the term spread can forecast stock returns better at a short-horizon, if indeed these variables do forecast stock returns somehow. These findings are consistent with the evidence in section (2).

Second, according to the correlation matrix in Panel A of Table (11), the dividend yield has the highest correlation with excess returns in the same time period. Furthermore, compared with correlation between $\widehat{cay}_{2,t}$ and excess returns, 0.05, the correlation between $\widehat{cay}_{1,t}$ and excess returns, 0.17, is substantially higher. This is consistent with what is supposed by the persistency of $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, that stock return at a short-horizon is more correlated with $\widehat{cay}_{1,t}$ than with $\widehat{cay}_{2,t}$. Moreover, while both trend deviations are positively correlated with excess returns and the term spread and negatively correlated with the dividend yield, the relative bill rate is positively correlated with $\widehat{cay}_{1,t}$ but negatively correlated with $\widehat{cay}_{2,t}$.

5.3 Quarterly Forecasting Regression

The forecasting power of the trend deviation, together with other return predictors, for one-quarter-ahead stock returns is investigated here. Table (12) reports one-quarter-ahead forecasts of the real returns and excess returns on the MSCI German index.

Focus on Panels A and B. The first row of each panel shows that one lag of dependent variables has no predictive power for returns. The statistics of adjusted R^2 are around zero. In addition, both the trend deviations, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, have no significant forecasting power for returns. Although the coefficients of the estimated trend deviations are insignificant, all of them are positive, which is consistent with the findings of Lettau and Ludvigson (2001). When returns are expected to increase in the future, rational investors will try to smooth their consumption flow by increasing consumption temporarily above its long-term common trend with both asset holdings and labor income. Thus, the trend deviation in the long-term

Table 12: **Forecasting Quarterly Stock Returns**

This table reports the estimates from OLS regression of stock returns on lagged variables at the head of the table. All returns are in logs using the MSCI German stock price index. The regressors are as follows: lag denotes a one-period lag of the dependent variables; $\widehat{cay}_{1,t}$ is $c_t - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$, where c_t is consumption, $a_{1,t}$ is household net worth as asset holdings, y_t is labor income; $\widehat{cay}_{2,t}$ is $c_t - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$, where $a_{2,t}$ is the private deposit as asset holdings; $d_t - p_t$ denotes the log dividend yield; $RREL_t$ is the relative bill rate and $TERM_t$ is the term spread. Newey-West corrected t-statistics appear in the parentheses below the coefficient estimate. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

♯	Constant	lag	$\widehat{cay}_{1,t}$	$\widehat{cay}_{2,t}$	$d_t - p_t$	$RREL_t$	$TERM_t$	$\overline{R}^2$
				Panel A: Real Return				
1	0.013	0.033						-0.01
	(1.30)	(0.44)						
2	3.304		0.861					0.01
	(1.35)		(1.34)					
3	0.027			0.026				-0.01
	(0.17)			(0.09)				
4	3.261	0.010	0.850					0.00
	(1.31)	(0.13)	(1.31)					
5	0.025	0.033		0.023				-0.01
	(0.16)	(0.43)		(0.08)				
				Panel B: Excess Return				
6	0.007	0.041						-0.01
	(0.71)	(0.54)						
7	3.529		0.921					0.01
	(1.44)		(1.44)					
8	0.038			0.060				-0.01
	(0.24)			(0.20)				
9	3.463	0.015	0.904					0.01
	(1.39)	(0.20)	(1.39)					
10	0.035	0.040		0.055				-0.01
	(0.22)	(0.52)		(0.18)				
				Panel C: Additional Control: Excess Return				
11	0.030				0.007			-0.01
	(0.40)				(0.29)			
12	0.008					**−1.548**		0.03
	(0.80)					(−3.41)		
13	−0.001						**0.763**	0.01
	(−0.05)						(2.01)	
14	3.876	−0.013	1.003		0.011	**−1.528**	0.218	0.02
	(1.48)	(−0.17)	(1.48)		(0.50)	(−2.34)	(0.51)	
15	0.076	0.019		0.048	0.014	**−1.383**	0.246	-0.00
	(0.35)	(0.23)		(0.14)	(0.62)	(−2.40)	(0.59)	

trend among consumption, asset holdings, and labor income should be positively correlated with future stock returns through the optimization behavior of investors.

Focus on Panel C. Row 11 shows that dividend yield has no predictive power for next quarter's excess returns. The adjusted R^2 is around zero. Other authors including Fama and French (1988a) show that the dividend yield has a better forecasting power of stock returns in excess of two years. Thus this finding is not too surprising. Furthermore, row 12 shows that the relative bill rate has highly significant forecasting power for next quarter's stock returns. The relative bill rate is negatively correlated with excess return and can explain 3% of the variation of next quarter's excess returns. The same findings are included in Hodrick (1992). A high relative bill rate in this quarter, which implies a business boom, is correlated with low excess returns in next quarter. Moreover, row 13 shows that the term spread has also significant forecasting power for next quarter's stock returns. The term spread is positively correlated with next quarter's stock excess returns, which is consistent with the findings of Fama and French (1989). However, the term spread does not help much to explain the variation of stock returns, according to the adjusted R^2 of 0.01, and its forecasting power is no longer significant when other predictors are included in the regression. Finally, including all predictors, the trend deviation, the dividend yield, the relative bill rate, and the term spread, in one regression shows that the only significant estimator is the coefficient of the relative bill rate, as can be seen in rows 14 and 15.

To conclude, using German quarterly data from 1971 to 2002, there is no evidence to support the view that the deviation from the shared trend of consumption, asset holdings, and labor income has forecasting power for next quarter's stock returns, whereas the relative bill rate does.

5.4 Long-horizon Forecasts

In this subsection, the predictability of long-horizon stock returns is investigated. According to the equation (15), the consumption-wealth ratio can signal the future expected return, consumption growth, or both. Theoretically the consumption-wealth ratio should help more to explain the long-term trend in asset returns or consumption growth than to explain the short-term trend. Besides, according to the summary statistics, $\widehat{cay}_{2,t}$ has a very high autocorrelation. This persistency can imply a long-term forecasting power for returns. Therefore, the forecasting power of the trend deviation in long-run is investigated with other return predictors. Two possible methods for investigating the predictability of long-horizons return are used: OLS regression and Vector Autoregression.

5.4.1 OLS Regression

Table (13) presents the results of single-equation regressions of either consumption growth or excess returns, over horizons from 1 quarter to 6 years. The dependent variable in Panel A is the H-period consumption growth rate, $\Delta c_{t+1} + \cdots + \Delta c_{t+H}$, and the dependent variable in Panel B is the H-period log excess returns on the MSCI German stock price index, $r_{t+1} - r_{f,t+1} + \cdots + r_{t+H} - r_{f,t+H}$.

First, in Panel B, both the trend deviations, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, have no forecasting power for stock excess returns at any horizon, the same is true of the dividend yield. These results are similar to the results from forecasting quarterly stock returns. In addition, the relative bill rate has significant forecasting power for excess returns at a horizon of 4 years and at horizons up to 2 years. For excess returns at horizons above 6 years, the relative bill rate has no longer significant forecasting power. According to the adjusted R^2 statistics in row 6, the relative bill rate has the strongest forecasting power for returns at a horizon of 1 year. This is consistent with the evidence in section (2), that the relative bill rate is mainly correlated with short-term stock returns. Moreover, when all the variables (trend deviations, the dividend yield, and the relative bill rate) are included in rows 7 and 8, the relative bill rate is still the only one which has significant forecasting power for excess returns.

Second, according to Panel A, the estimated trend deviation, $\widehat{cay}_{1,t}$, has significant forecasting power for consumption growth at long-horizons from 2 years to 4 years, while $\widehat{cay}_{2,t}$ has no forecasting power for future consumption growth at

Table 13: **Long-horizon Regressions of Excess Stock Returns**

This table reports the OLS estimates from long-horizon regression of stock excess returns on lagged variables in the second column. The dependent variable in Panel A is the H-period consumption growth rate, $\Delta c_{t+1} + \cdots + \Delta c_{t+H}$. The dependent variable in Panel B is the sum of H log excess returns on the MSCI index, $r_{t+1} - r_{f,t+1} + \cdots + r_{t+H} - r_{f,t+H}$. The regressors are as follows: $\widehat{cay}_{1,t}$ is $c_t - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$, where c_t is consumption, $a_{1,t}$ is household net worth as asset holdings, y_t is labor income; $\widehat{cay}_{2,t}$ is $c_t - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$, where $a_{2,t}$ is the private deposit as asset holdings; $d_t - p_t$ denotes the log dividend yield; $RREL_t$ is the relative bill rate; $TERM_t$ is the term spread; and combinations thereof. Newey-West corrected t-statistics appear in the parentheses below the coefficient estimate and adjusted R^2 statistics appear in square brackets. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

		Forecast Horizon H							
Row	Regressors	1	2	3	4	8	12	16	24
		Panel A: Consumption Growth							
1	$\widehat{cay}_{1,t}$	−0.079	−0.140	−0.166	−0.223	**−0.488**	**−0.772**	**−0.838**	−0.431
		(−1.59)	(−1.69)	(−1.46)	(−1.43)	(−2.09)	(−3.13)	(−2.70)	(−0.90)
		[0.01]	[0.03]	[0.03]	[0.04]	[0.08]	[0.15]	[0.14]	[0.02]
2	$\widehat{cay}_{2,t}$	−0.023	−0.039	−0.043	−0.051	−0.055	−0.069	−0.029	0.277
		(−1.16)	(−1.04)	(−0.82)	(−0.78)	(−0.54)	(−0.53)	(−0.19)	(1.24)
		[0.00]	[0.01]	[0.00]	[0.00]	[−0.00]	[−0.00]	[−0.01]	[0.03]
		Panel B: Excess Stock Returns							
3	$\widehat{cay}_{1,t}$	0.921	1.448	2.067	1.911	0.723	−2.853	−3.827	1.149
		(1.44)	(1.06)	(1.15)	(0.93)	(0.27)	(−1.13)	(−1.14)	(0.29)
		[0.01]	[0.02]	[0.03]	[0.01]	[−0.01]	[0.01]	[0.02]	[−0.01]
4	$\widehat{cay}_{2,t}$	0.060	−0.025	0.110	0.212	0.284	−0.236	−0.932	−2.085
		(0.20)	(−0.04)	(0.14)	(0.21)	(0.19)	(−0.15)	(−0.47)	(−0.93)
		[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.00]	[0.02]
5	$d_t - p_t$	0.007	0.022	0.018	0.013	0.043	0.010	0.042	−0.001
		(0.29)	(0.48)	(0.30)	(0.17)	(0.31)	(0.06)	(0.61)	(−0.01)
		[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]	[−0.01]
6	$RREL_t$	**−1.548**	**−2.918**	**−4.219**	**−5.035**	**−5.386**	−6.467	**−7.732**	−0.968
		(−3.41)	(−3.48)	(−3.71)	(−4.25)	(−2.60)	(−1.95)	(−2.20)	(−0.23)
		[0.03]	[0.05]	[0.08]	[0.09]	[0.05]	[0.06]	[0.08]	[−0.01]
7	$\widehat{cay}_{1,t}$	0.998	1.587	2.264	2.103	0.871	−2.580	−3.457	1.207
		(1.51)	(1.14)	(1.25)	(1.04)	(0.32)	(−1.00)	(−1.08)	(0.30)
	$d_t - p_t$	0.010	0.027	0.026	0.023	0.054	0.026	0.059	−0.005
		(0.48)	(0.72)	(0.54)	(0.36)	(0.40)	(0.15)	(0.32)	(−0.02)
	$RREL_t$	**−1.645**	**−3.087**	**−4.426**	**−5.190**	**−5.504**	−6.387	**−7.666**	−1.029
		(−3.03)	(−3.30)	(−3.52)	(−3.87)	(−2.51)	(−1.89)	(−2.18)	(−0.24)
		[0.04]	[0.07]	[0.11]	[0.10]	[0.04]	[0.06]	[0.09]	[−0.03]
8	$\widehat{cay}_{2,t}$	0.064	0.003	0.118	0.205	0.460	−0.375	−1.051	−2.160
		(0.19)	(0.00)	(0.14)	(0.19)	(0.32)	(−0.24)	(−0.58)	(−0.98)
	$d_t - p_t$	0.012	0.028	0.030	0.029	0.069	0.020	0.041	0.017
		(0.52)	(0.67)	(0.55)	(0.39)	(0.51)	(0.13)	(0.23)	(0.07)
	$RREL_t$	**−1.554**	**−2.962**	**−4.243**	**−5.042**	**−5.438**	−6.606	**−8.032**	−1.420
		(−3.32)	(−3.59)	(−3.75)	(−4.20)	(−2.56)	(−1.96)	(−2.28)	(−0.39)
		[0.01]	[0.04]	[0.07]	[0.08]	[0.04]	[0.05]	[0.08]	[0.00]

any horizon. These findings are different from the results of Lettau and Ludvigson (2001). They find no predictive power of cay_t for consumption growth.

To summarize, none of the estimated fluctuations in the consumption-wealth ratio, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, has forecasting power for the long-horizon stock excess return. However, $\widehat{cay}_{2,t}$, which is calculated based on the constructed household net worth as the measure of asset wealth, has significant forecasting power for consumption growth at long-horizons from 2 years to 4 years. And the relative bill rate has a significant predictive power for returns at long-horizons up to 4 years.

5.4.2 Vector Autoregression (VAR)

Table (14) presents two first-order VARs. In Panel A, there are four variables: excess returns on the MSCI German index, the relative bill rate, the dividend yield, and the estimated trend deviation, $\widehat{cay}_{1,t}$, which is calculated by using household net worth as the measure of asset holdings. In Panel B, instead of $\widehat{cay}_{1,t}$, $\widehat{cay}_{2,t}$, which is calculated by using private deposits as the measure of asset holdings, is investigated with three other variables in a first-order VARs.

Panel A and Panel B deliver the same results as those from long-horizon OLS regression of stock returns in Table (13). The only variable which has the significant forecasting power for stock excess returns is the relative bill rate. The deviation from the shared trend in consumption, asset holdings, and labor income has no significant forecasting power for excess returns. Although both of the estimated trend deviations, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$, have no significant coefficients at the five percent level, $\widehat{cay}_{1,t}$ has a more significant coefficient than $\widehat{cay}_{2,t}$. The same is true in the analysis of forecasting quarterly stock returns and long-horizon OLS regression of stock returns. Thus, household net worth, from which $\widehat{cay}_{1,t}$ is calculated, is a better measure of asset holdings. The next section only uses household net worth as the measure of assets holdings in the error correction model (ECM).

Table 14: **Vector Autoregression of Excess Returns**

This table reports the estimates from vector autoregressions (VARs) of returns, the relative bill rate, the dividend yield, and the estimated trend deviation terms, $\widehat{cay}_{1,t}$ and $\widehat{cay}_{2,t}$. $r_t - r_{f,t}$ denotes quarterly log excess returns on the MSCI German index. $d_t - p_t$ denotes the log dividend yield. $RREL_t$ is the relative bill rate. $TERM_t$ is the term spread. $\widehat{cay}_{1,t}$ is $c_t - \widehat{\beta}_a a_{1,t} - \widehat{\beta}_y y_t$, where c_t is consumption, $a_{1,t}$ is household net worth as asset holdings, y_t is labor income. $\widehat{cay}_{2,t}$ is $c_t - \widehat{\beta}_a a_{2,t} - \widehat{\beta}_y y_t$, where $a_{2,t}$ is the private deposit as asset holdings. t-statistics appear in the parentheses below the coefficient estimate and adjusted R^2 statistics appear in the last column. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

Dependent Variable	Constant	$r_t - r_{f,t}$	$RREL_t$	$d_t - p_t$	$\widehat{cay}_{1,t}$	$\widehat{cay}_{2,t}$	$\overline{R}^2$
			Panel A				
$r_{t+1} - r_{f,t+1}$	3.904	−0.011	**−1.660**	0.009	1.011		0.03
	(1.81)	(−0.12)	(−2.234)	(0.37)	(1.79)		
$RREL_{t+1}$	0.095	−0.000	**0.753**	−0.001	0.026		0.56
	(0.55)	(−0.03)	(12.56)	(−0.44)	(0.56)		
$d_{t+1} - p_{t+1}$	−2.209	0.008	**2.073**	**0.947**	−0.532		0.91
	(−0.97)	(0.08)	(2.63)	(34.86)	(−0.89)		
$\widehat{cay}_{1,t+1}$	**−0.579**	0.008	−0.032	0.001	**0.848**		0.72
	(−3.16)	(1.04)	(−0.50)	(0.32)	(17.66)		
			Panel B				
$r_{t+1} - r_{f,t+1}$	0.086	0.022	**−1.527**	0.014		0.067	0.01
	(0.45)	(0.24)	(−2.03)	(0.49)		(0.24)	
$RREL_{t+1}$	−0.005	0.001	**0.756**	−0.001		−0.004	0.56
	(−0.33)	(0.07)	(12.61)	(−0.45)		(−0.17)	
$d_{t+1} - p_{t+1}$	−0.179	−0.009	**2.009**	**0.946**		0.001	0.91
	(−0.89)	(−0.09)	(2.55)	(32.57)		(0.00)	
$\widehat{cay}_{2,t+1}$	**−0.042**	−0.005	−0.101	−0.004		**0.942**	0.92
	(−2.18)	(−0.55)	(−1.32)	(−1.37)		(33.91)	

6 Estimate cay_t in an Error Correction Model (ECM)

The last section investigates the forecasting power of the consumption-wealth ratio with the techniques included in Lettau and Ludvigson (2001). In the dynamic least squares (DLS) specification of the regression of consumption on asset holdings and labor income,

$$c_{n,t} = \alpha + \beta_a a_t + \beta_y y_t + \sum_{i=-k}^{k} b_{a,i} \Delta a_{t-i} + \sum_{i=-k}^{k} b_{y,i} \Delta y_{t-i} + \epsilon_t,$$

big positive autocorrelations in the estimated residual have been found, as can be seen in Table (9). The Durbin-Watson statistic of the residual in regression of consumption on household net worth and labor income is 0.37. In addition, it has been proven that the data of consumption, asset holdings, and labor income are each integrated of order 1, and are cointegrated, as can be seen in Table (7) and (8). Thus, in order to check the robustness of the estimates of the DLS specification for regression with cointegrated variables, I estimate an error-correction specification of the same co-integrated system in this section.

The error-correction representation is a convenient representation of co-integrated systems. It is documented by many authors like Granger and Weiss (1983), Engle and Granger (1987), and Hassler (2001). A simple version of the error correction model (ECM) can be expressed as follows. If variables z_t and x_t are each integrated of order 1, and are cointegrated, and these variables have the equilibrium relationship like,

$$z_t = \beta x_t, \tag{24}$$

then an error correction term is one such as $z_t - \beta x_t$. Hence, the corresponding Error Correction Model (ECM) is,

$$\Delta z_t = \alpha_0 + \alpha_1 (z_{t-1} - \beta x_{t-1}) + \alpha_2 \Delta z_{t-1} + \alpha_3 \Delta x_t + u_t, \tag{25}$$

where $\alpha_{0,1,2,3}$ and β are coefficients and u_t is the error term. In equation (25), each term is stationary and is not cointegrated with each other. Therefore, OLS estimation of equation (25) delivers a better unbiased linear estimator for the cointegration parameter β than the static regression, $z_t = \beta x_t + u_t$. In addition, α_1 can show how fast the error correction term $z_t - \beta x_t$ adjusts the z_t through Δz_t.

6.1 Estimation of ECM

According to equation (25), the static regression of consumption on asset holdings and labor income,

$$c_{n,t} = \beta_0 + \beta_a a_t + \beta_y y_t + \epsilon_t,$$

has the following corresponding error-correction model (ECM),

$$\Delta c_{n,t} = \alpha_0 + \alpha_1(c_{n,t-1} - \beta_a a_{t-1} - \beta_y y_{t-1}) + \alpha_2 \Delta c_{n,t-1} + \alpha_3 \Delta a_t + \alpha_4 \Delta y_t + \epsilon_t, \quad (26)$$

where α and β are coefficients, ϵ_t is the error term.

To implement the regression (26), household net worth is used as the only measure of asset holdings, since it delivers a more significant coefficient of the trend deviation for stock returns than private deposits, as could be seen in the last section. Using German data from the first quarter of 1971 to the last quarter of 2002 generates the following point estimates,

$$\begin{aligned} c_{n,t} \;=\; &-\underset{(-2.23)}{0.41} - \underset{(-2.41)}{0.12}\,(c_{n,t-1} - \underset{(11.96)}{0.90} a_{t-1} - \underset{(1.47)}{0.23} y_{t-1}) \\ &-\underset{(-1.09)}{0.10}\Delta c_{n,t-1} + \underset{(2.44)}{0.45}\Delta a_t + \underset{(2.88)}{0.18}\Delta y_t\,, \end{aligned} \quad (27)$$

where t-statistics appear in parentheses below the coefficient estimates. The Durbin-Watson statistic for equation (27) is 1.98, which is much better than the corresponding Durin-Watson statistic, 0.37, in the DLS specification. Because there are less autocorrelations in the residuals of ECM specification of the regression of consumption on assets and labor income than in the residuals of DLS specification, ECM specification delivers better estimators for cointegrating parameters, β_a and β_y. Translating the $\widehat{\beta_a}$and $\widehat{\beta_y}$ from equation (27) to a static regression gives,

$$c_{n,t} = -3.50 + 0.90 a_t + 0.23 y_t. \quad (28)$$

Table 15: **Summary Statistics**

$r_t - r_{f,t}$ denotes quarterly log excess returns on the MSCI German stock price index. $d_t - p_t$ denotes the log dividend yield. $RREL_t$ is the relative bill rate and $TERM_t$ is the term spread. $\widehat{cay}_t$ is $c_t - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, where c_t is consumption, a_t is household net worth, and y_t is labor income. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

	$r_t - r_{f,t}$	$d_t - p_t$	$RREL_t$	$TERM_t$	$\widehat{cay}_t$
Panel A: Correlation Matrix					
$r_t - r_{f,t}$	1.00	-0.22	-0.16	0.17	0.12
$d_t - p_t$		1.00	0.05	-0.17	-0.41
$RREL_t$			1.00	-0.49	0.04
$TREM_t$				1.00	-0.06
$\widehat{cay}_t$					1.00
Panel B: Univariate Summary Statistics					
Mean	0.009	-3.246	0.000	0.011	-3.504
Standard eror	0.114	0.398	0.014	0.017	0.018
Autocorrelation	0.041	0.949	0.754	0.890	0.85

And the estimated trend deviation $\widehat{cay}_t = c_{n,t} - 0.90a_t - 0.23y_t$.

The correlations of $\widehat{cay}_t$ with excess returns, the dividend yield, the relative bill rate, and the term spread are reported in Panel A of Table (15). $\widehat{cay}_t$ is positively correlated with excess returns and the relative bill rate, and is negatively correlated with the dividend yield and the term spread. As can be seen in Panel B of Table (15), $\widehat{cay}_t$ is much less persistent than the dividend yield and also varies less than the dividend yield. Compared with the summary statistics in Table (11), $\widehat{cay}_t$ has a similar distribution as $\widehat{cay}_{1,t}$, calculated by the DLS specification. Figure (1), which plots the standardized $\widehat{cay}_t$ and $\widehat{cay}_{1,t}$, shows that both series have similar variation. This implies that although the ECM specification gives better estimates of the parameters of the shared trend in consumption, assets, and labor income than the DLS specification, the estimated trend deviations from these two specifications have similar properties.

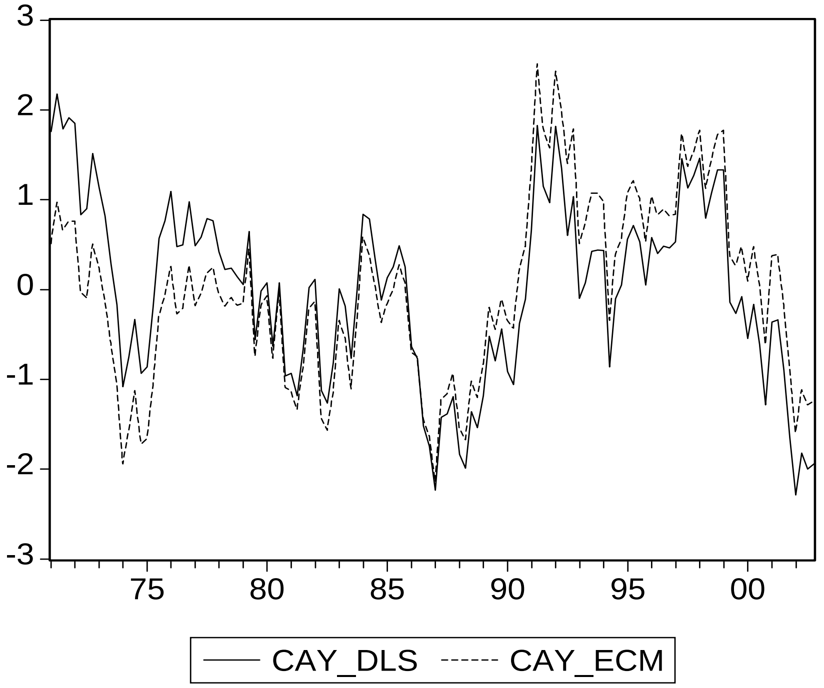

Figure 1: The standardized $\widehat{cay}_t$ and $\widehat{cay}_{1,t}$. $\widehat{cay}_t$, CAY-ECM, is calculated by using the estimates of the error correction model (ECM) of the regression of consumption on household net worth and labor income. $\widehat{cay}_{1,t}$, CAY-DLS, is calculated by using the estimates of the dynamic least squares (DLS) specification of the same regression.

6.2 Forecasting Regressions

In this subsection, the quarterly forecasting regressions and long-horizon OLS regressions of stock returns are presented. Both analyses show that the fluctuations in the consumption-wealth ratio have no forecasting power for stock returns at any horizon.

Table (16) reports the estimators from OLS regressions of stock returns on one-quarter lagged trend deviation $\widehat{cay}_t$, the dividend yield, the relative bill rate, and the term spread. The dependent variable in Panel A is the log real return on MSCI German index. And the dependent variable in Panel B is the log excess return. As can be seen in Table (16), the trend deviation, $\widehat{cay}_t$, has no significant forecasting power neither for stock real returns, nor for stock excess returns. When all independent variables are included in row 5, the only variable which has significant forecasting power for excess returns, is the relative bill rate. These results are similar to the results from the DLS specification of the co-integrated system of consumption, assets, and labor income, compared with Table (12).

Table (17) reports coefficient estimates from vector autoregressions (VARs) of excess returns, the relative bill rate, the dividend yield, and the trend deviation. It shows similar results as quarterly forecasting stock returns. As can be seen from the excess returns regression in row 1, the relative bill rate is only one, which forecasts the future excess returns. Estimated fluctuations in the consumption-wealth ratio, $\widehat{cay}_t$, have no forecasting power for stock returns. It can be shown that the long-horizon OLS regressions of excess returns deliver the same results. These findings are similar to the results from the DLS specification.

Table 16: **Forecasting Quarterly Stock Returns**

This table reports the estimates from OLS regression of stock returns on lagged variables at the head of the table. All returns are in logs using the MSCI German stock price index. The regressors are as follows: lag denotes a one-period lag of the dependent variables; $\widehat{cay}_t$ is $c_t - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, where c_t is consumption, a_t is household net worth, y_t is labor income; $d_t - p_t$ denotes the log dividend yield. $RREL_t$ is the relative bill rate and $TERM_t$ is the term spread. Newey-West corrected t-statistics appear in the parentheses below the coefficient estimate. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

	Constant	lag	$\widehat{cay}_t$	$d_t - p_t$	$RREL_t$	$TERM_t$	$\overline{R}^2$
			Panel A: Real Returns				
1	2.347		0.666				0.00
	(1.20)		(1.19)				
2	2.290	0.020	0.650				-0.00
	(1.17)	(0.27)	(1.16)				
			Panel B: Excess Returns				
3	2.371		0.674				0.00
	(1.18)		(1.18)				
4	2.294	0.028	0.653				-0.00
	(1.15)	(0.37)	(1.14)				
5	3.729	0.009	1.033	0.033	**−1.384**	0.416	0.02
	(1.53)	(0.12)	(1.53)	(1.17)	(−2.27)	(1.03)	

Table 17: **Vector Autoregression of Excess Returns**

This table reports the estimates from vector autoregressions (VARs) of excess returns, the relative bill rate, the dividend yield, and the trend deviation, $\widehat{cay}_t$. $r_t - r_{f,t}$ denotes quarterly log excess returns on the MSCI German stock price index. $d_t - p_t$ denotes the log dividend yield. $RREL_t$ is the relative bill rate. $TERM_t$ is the term spread. $\widehat{cay}_t$ is $c_t - \widehat{\beta}_a a_t - \widehat{\beta}_y y_t$, where c_t is consumption, a_t is household net worth, y_t is labor income. t-statistics appear in the parentheses below the coefficient estimate and adjusted R^2 statistics appear in the last column. Significant coefficients at the five percent level are highlighted in bold face. The sample period is the first quarter of 1971 to the fourth quarter of 2002.

Dependent Variable	Constant	$r_t - r_{f,t}$	$RREL_t$	$d_t - p_t$	$\widehat{cay}_t$	$\overline{R}^2$
$r_{t+1} - r_{f,t+1}$	3.548	0.014	**−1.629**	0.029	0.983	0.03
	(1.63)	(0.15)	(−2.19)	(1.05)	(1.61)	
$RREL_{t+1}$	0.009	0.001	**0.756**	−0.001	0.003	0.56
	(0.05)	(0.08)	(12.61)	(−0.35)	(0.007)	
$d_{t+1} - p_{t+1}$	−3.100	−0.003	**2.085**	**0.930**	−0.820	0.91
	(−1.35)	(−0.03)	(2.66)	(31.48)	(−1.28)	
$\widehat{cay}_{t+1}$	**−0.586**	0.005	−0.024	−0.003	**0.835**	0.73
	(−3.23)	(0.68)	(−0.39)	(−1.14)	(16.41)	

7 Possible Answer for Results of German Data

Using the German quarterly data from 1971 to 2002, I have not found evidence that the fluctuations in the consumption-wealth predict stock returns. And the estimation of parameters of the shared trend in consumption, asset holdings, and labor income delivers a higher share of asset holdings in aggregate wealth and the sum of the coefficients of asset holdings and labor income in regression of consumption is greater than one. These three main results are different from what Lettau and Ludvigson (2001) show. Thus, this section tries to explain them.

First, as can be seen in Table (9) and equations (22) and (28), no matter which measure of asset holdings is used and which method for the regression of consumption on asset holdings and labor income is used, German data give a higher share of asset holdings in aggregate wealth than U.S. data do. And the constructed household net worth has especially high coefficients, 0.92 for the DLS specification and 0.90 for the ECM specification. One possible answer is that the used German data for asset holdings are less volatile than the U.S. data used by Lettau and Ludvigson. Because the dependent variable, consumption, is not volatile, a less volatile regressor gets higher weights. The first measure that I used for German assets is the constructed household net worth. Because the quarterly net worth is constructed from the annual net worth, the variation over the year cannot be included. The second measure of German assets is the private deposits. Because the values of other financial assets like shares and bonds are more volatile than the value of deposits, only using deposits as the measure of wealth can reduce the variation of asset holdings. Thus, OLS regression of not so volatile consumption puts more weights on the coefficients of more stable asset holdings.

This answer can be proven in the data. Table (18) shows the summary statistics of consumption, asset holdings, and labor income for German data and U.S. data used by Lettau and Ludvigson (2001). As can be seen in row 2, household net worth is less volatile in German data than in U.S. data. The standard deviation of household net worth is 0.21 in Germany and 0.30 in the USA. And consumption is not so volatile according to the standard deviation of 0.27 in U.S. data and 0.21 in

Table 18: **Summary Statistics of Consumption, Assets, and Labor Income**

All data are quarterly, seasonally adjusted, per capital real log variables. lc_t, la_t, and ly_t denote the consumption, household net worth, and labor income in U.S. data from the fourth quarter of 1952 to the third quarter of 1998. These data are used by Lettau and Ludvigson (2001). c_t, $a_{1,t}$, $a_{2,t}$, and y_t denote the consumption, household net worth, private deposits, and labor income in German data from the first quarter of 1971 to the fourth quarter of 2002.

	lc_t	la_t	ly_t	c_t	$a_{1,t}$	$a_{2,t}$	y_t
Mean	9.38	11.03	9.18	3.24	6.74	4.73	2.86
Standard Error	0.27	0.30	0.31	0.21	0.21	0.33	0.10

German data. Thus, the coefficient of household net worth (0.9) is much higher in German data than it (0.31) is in U.S. data. Less volatile asset holdings lead to a high coefficient of assets in the regression of consumption, where consumption is not volatile. This can also be seen in the fact that when private deposits, which are more volatile (0.33 as standard deviation), are used for asset holdings, the coefficient of asset holdings is reduced to 0.46.

Second, the sum of the coefficients of assets and labor income in regression of consumption is equal to $1/\lambda$ and smaller than one, according to the assumption of Lettau and Ludvigson (2001). However, with German data the estimated sum of the coefficients of assets and labor income is bigger than one. One possible answer is that the assumption of Lettau and Ludvigson (2001), namely that log total consumption is a linear function of log nondurable consumption, $c_t = \lambda c_{n,t}$, where $\lambda < 1$, is not necessarily true in the data. A linear relation between total consumption and nondurable consumption is too simple for the reality. Another possible answer is that the volatility of asset holdings and labor income together is smaller in German data than it is in U.S. data. Because the dependent variable, consumption, is not so volatile, less volatile regressors get high weights together. As can be seen in Table (18), the standard deviations of asset holdings and labor income together in German data are smaller than or equal to 0.43, while the standard deviation of assets and labor income together is 0.61 in U.S. data. Thus, the sum of coefficients of stable regressors in the regression of consumption is high.

Third, German data do not show that the fluctuations in the consumption-wealth ratio predict stock returns. One possible answer is that the German consumption growth rate is more volatile than U.S. consumption growth and at the same time German consumption growth is less correlated with stock returns than U.S. consumption growth. German consumption growth has a standard deviation of 0.98%, while U.S. consumption growth has a standard deviation of 0.48%. The correlation between German consumption growth and the log real return on MSCI German index is -0.037, while the correlation between U.S. consumption growth and the log real return on the value-weighted CRSP Index is 0.139. Therefore, a more volatile German consumption growth, which is not correlated with log real stock returns, reduces the forecasting power of the consumption-wealth ratio for stock returns, according to equation (15).

Another way to explain the lack of predictive power of the consumption-wealth ratio for stock returns is to look at the importance of stock markets for aggregate wealth in Germany. The basic mechanism of the predictive power of the consumption-wealth ratio is the following: if the future stock returns are expected to increase and these stocks are a part of the consumer's wealth, then the consumer who wishes to smooth the consumption flow (according to the permanent income hypothesis) will temporarily increase his consumption above its long-term relationship with both assets and labor income. Through this "wealth effect", the movements of future stock returns are correlated with the fluctuations of the shared trend in consumption, assets, and labor income. Hence, the greater the importance of stock markets for aggregate wealth of consumers, the stronger is the relationship between stock returns and consumption. And the stronger the relationship between stock returns and consumption, the more influential is the predictive power of the consumption-wealth ratio for stock returns. Based on this view, the following three points explain the lack of predictive power of the consumption-wealth ratio for stock returns.

A low proportion of stock markets capitalization to GDP in Germany reduces the predictive power of the consumption-wealth ratio for stock returns. As can be seen in row 5 of Table (19), stock markets capitalization is about 135% of GDP in the

Table 19: **Market Capitalization and Stock Ownership**

This table reports the information about the stock ownership and market capitalization in Germany and in the USA. All the numbers are in million dollars in 2001. Data of stock ownership are obtained from the Coordinated Portfolio Investment Survey (CPIS) from International Monetary Fund (IMF). Data of market capitalization are obtained from the Federation International des Bourses de Valeur (FIBV). U.S. market capitalization is the sum of the market capitalization of Amex, Nasdaq, and NYSE. Data of GDP are from the Organization for Economic Cooperation and Development (OECD).

♯	Variable	Germany	USA
1	Stock Market Capitalization	1071748.73	13826484.49
2	GDP	1836880.06	10208100.00
3	Domestic Holdings of Foreign Equity	381184.28	1599368.40
4	Foreign Holdings of Domestic Equity	271366.61	997821.35
5	Market Capitalization / GDP	58%	135%
6	Domestic Holdings of Foreign Equity / Market Capitalization	32%	11%

USA in 2001, while stock markets account for only 58% of GDP in Germany in 2001. Germany has a much lower proportion of stock markets to national GDP than the USA. Equity accounts for a less important part of aggregate wealth for consumers in Germany than for consumers in the USA. This implies a weak relationship between consumption and stock returns in Germany. Thus, the fluctuations in the consumption-wealth ratio cannot reflect the fluctuations in future stock returns.

Furthermore, high holdings of foreign stocks in Germany weaken the relationship between domestic stock markets and domestic consumption. As can be seen in row 6 of Table (19), shares of foreign equity held by Germans count for 32% of the total stock market capitalization in Germany, while foreign equity is only 11% of the stock market capitalization in the USA. The movement of foreign stock markets has an important effect on the German consumers' behavior. This weakens the relationship between domestic stock markets and consumption in Germany, thus reducing the predictive power of the consumption-wealth ratio for domestic stock returns.

Moreover, an extensive "pay-as-you-go" pension system in Germany reduces the importance of stock markets for aggregate wealth. A "pay-as-you-go" pension system is one in which the government pays a pension to the old, which is financed by taxing the young. People get a much higher pension payments in Germany than in the USA. This pension payment is a claim on the future labor income of the younger generation, but not a claim on their own saving or investment in stock markets. Only since 2002, a so called ”Riester Rente” has been introduced in Germany, which asks people to invest their money in investment funds or other financial products by themselves, in order to prepare for the living costs of old age. Thus, stock markets do not play an important role in ”pension wealth” in Germany. The weakened link between stock returns and total wealth implies the lack of predictive power of the consumption-wealth ratio for stock returns in Germany.

8 Robustness of the Analysis

This section discusses the credibility of the results, that the fluctuations in the aggregate consumption-wealth ratio has no predictive power for stock returns in German data from the first quarter of 1971 to the fourth quarter of 2002.

One of the most difficult parts in the analysis of the German consumption-wealth ratio appears at the beginning of the investigation - "Data Construction". Because the quarterly time series of household net worth, the measure of assets holdings included in Lettau and Ludvigson (2001), is nowhere to be found in Germany, I have to construct the data as accurately as possible by myself. Using monthly private deposits from 1970 to 2003, monthly share capital for the whole German market from 1960 to 2003, annual non-financial assets for the whole German economy from 1960 to 2000, and annual household net worth from 1991 to 2001, I estimate an OLS regression of household net worth on private deposits, share capital, and non-financial assets. Private deposits and shares belong to the most important part of financial assets, which, together with non-financial assets, comprise the household net worth. If I use the original annual frequency of household net worth, there are only 11 observations for this OLS regression. In order to improve the accuracy of the estimates, I translate the frequency of all the data to a quarterly basis. Thus, I can estimate regression of household net worth on other regressors with 45 observations, i.e. from the first quarter of 1992 to the first quarter of 2002. As can be seen in equation (23), this OLS regression has significant t-statistics for the coefficients and quite a high R^2 statistic of 0.97. Figure (2) shows that the fitted household net worth from the regression is very similar to the original household net worth. Using these estimates, I construct the German quarterly data of household net worth from the first quarter of 1971 to the last quarter of 2002. Although this construction of the household net worth is quite successful, the quarterly variations of the unobservable true data are possibly not included because the construction is based on the original annual household net worth. Therefore, in order to provide a picture of quarterly variation of asset holdings, I use available quarterly private deposits as the second measure of asset holdings. Similar

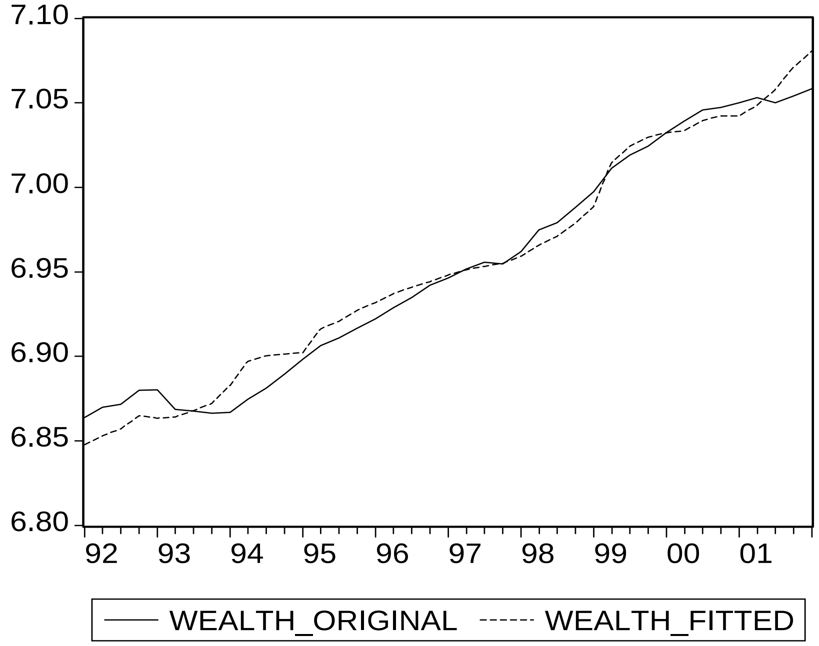

Figure 2: The original household net worth and the estimated household net worth. The sample period is the first quarter of 1992 to the first quarter of 2002. The estimated household net worth is calculated using private deposits, shares, and non-financial assets.

assumptions are also known in the literature. Campbell (1996) only uses financial assets as the measure of asset holdings. Hassler (2001) uses cumulate savings as the measure of asset holdings. However, it turns out that no matter which measure I use for asset holdings, the estimated fluctuations of the consumption-wealth ratio, $\widehat{cay_t}$, has no forecasting power for stock returns in either case.

Another difficulty in the analysis is the correct estimation of the regression of consumption on asset holdings, and labor income, where these three variables are cointegrated. Lettau and Ludvigson (2001) use the dynamic least squares (DLS) specification for this regression, which adds leads and lags of the first difference of the independent variables to a standard OLS regression of consumption on labor income and asset holdings. It is stated that the DLS specification can eliminate the effects of regressor endogeneity on the distribution of the least squares estimators, and the OLS estimates of cointergrating parameters are "superconsistent". However, there are big positive autocorrelations in the residuals of the DLS specification of the OLS regresssion of consumption on asset holdings, and labor income. This implies that the DLS specification is not a good model to estimate the relation between co-integrated consumption, asset holdings, and labor income. Furthermore, the estimates vary with the number of leads/lags of the first differences. Though the Akaike Information Criterion and the Schwarz Criterion are used to choose the number of leads/lags, these two criteria do not always give the same answer. And no matter which criterion is used, big autocorrelations remain in residuals. Therefore, in order to check the robustness of the estimation of the DLS specification for co-integrated consumption, asset holdings, and labor income, I use an error correction model (ECM) to specificate the same co-integrated system, as can be seen in section (6). However, it turns out, although ECM gives better estimates for the cointegrating parameters than the DLS specification, the estimated fluctuations in the consumption-wealth ratio, $\widehat{cay_t}$, have no forecasting power for stock return in either cases.

To summarize, the data construction and estimation of the model is conducted as carefully as possible, which leads to robust forecasting results. According to the available data in Germany and the possible estimation techniques, there is no evidence to support the view that fluctuations in the consumption-wealth ratio has predictive power for stock returns.

9 Summary

It is widely accepted that the stock returns are predictable by financial variables such as the dividend-price ratio, the dividend-earning ratio, the relative bill rate, and other financial indicators. There are only few macroeconomic variables which are found to have the predictive power for stock returns. The consumption-wealth ratio is one of them. Using U.S. quarterly data from 1952 to 1998, Lettau and Ludvigson (2001) show that the fluctuations in the consumption-wealth ratio are strong predictors of stock returns at short and intermediate horizons.

In this thesis, I investigate the consumption-wealth ratio using German data from the first quarter of 1971 to the last quarter of 2002. It is shown that with the available German data and possible estimation techniques, the fluctuations in the log consumption-wealth ratio cannot predict stock returns at any horizon.

First, private deposits, shares, and non-financial assets are used to construct the data of household net worth, because the quarterly time series of German household net worth is not available. In addition to net worth, private deposits are used as the second measure of the quarterly data of assets holdings, in order to capture the quarterly variation in the asset holdings. The data of consumption, asset holdings, labor income are shown to be cointegrated with rank 1 and each of them is integrated of order 1.

Second, the OLS estimation of the dynamic least squares (DLS) specification of the regression of consumption on assets holdings and labor income shows that asset holdings have a very big share in the aggregate wealth, and the sum of the coefficients of assets and labor income is greater than one. The estimated fluctuations in the log consumption-wealth ratio can predict both consumption growth and asset growth. Thus, the estimated deviations from the shared trend in consumption, labor income, and assets are better described as transitory movements in assets and consumption than as transitory movements in labor income.

Third, the forecasting analysis shows that fluctuations in the consumption-wealth ratio cannot predict stock returns at any horizon, but they can predict consumption growth at horizons from 2 to 4 years. In addition, the estimated consumption-wealth ratio based on household net worth as asset holdings has a better performance than the estimated consumption-wealth ratio based on private deposits as asset holdings in the analysis of forecasting stock returns. Moreover, the OLS estimation of the error correction model (ECM) of the regression of consumption on assets and labor income delivers the same results in the forecasting analysis, namely that the estimated fluctuations in the log consumption-wealth ratio cannot forecast stock returns.

One possible answer for these results is that the used quarterly data of German household net worth are less volatile than the U.S. data. In addition, compared with U.S. data, the more volatile German consumption growth, which is less correlated with stock returns, reduces the predictive power of the consumption-wealth ratio for stock returns. The weakened link between stock returns and consumption growth can be due to the fact that stock markets have a much smaller size in proportion to national GDP in Germany than in the USA. Furthermore, high holdings of foreign stocks and high pension payments in Germany weaken the link between domestic stock markets and aggregate wealth.

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