GENERALIZED METHOD OF MOMENTS APPLICATION TO CCAPM

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Generalized Method of Moments Application to CCAPM

Genelleştirilmiş Momentler Yönteminin
Tuketim Temelli Varlik Fiyatlama Modeline Uygulanmasi
Generalized Method of Moments Application to CCAPM

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Özetçe

Bu calismada, Genelleştirilmiş Momentler Yöntemi kullanilarak, Subat 1959 ve Subat 2015 zaman araliginda, S&P500 verisi ile riskten kacinma katsayisi ve indirim faktoru hesaplanmistir. Hansen and Singleton (1982)'da elde edilen sonuclara kiyasla, riskten kacinma katsayisi icin daha yuksek sonuc elde edilirken risk faktoru icim benzer sonuclara ulasilmistir.

Abstract

In this study, using GMM approach, the risk aversion coefficient of the economic agents and the discount factor on the S&P500 data is estimated for the period between February 1959 and February 2015. Comparing to the results obtained by Hansen and Singleton (1982), while higher values are obtained for the risk aversion coefficient of the agents, α, similar values for the time discount factor, β are obtained.

To my family...

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Contents

1 Introduction

The increases in the power of new calculation tools in the last decades allow us dynamic stochastic models to be studied by numerical simulation techniques (Marcet and Marshall, 1994). The purpose of this master thesis is to implement the econometric estimation which allows us to estimate the parameters of economic agents' dynamic objective functions.

In this thesis, the model from Hansen and Singleton (1982) is applied to the aggregate consumption data for the period between February 1959 and February 2015. The main contribution of this study is to examine the external validity of results by re-estimating the same model on the updated data. With the application of the Generalized Method of Moments (GMM), the parameters, which characterize preferences in the model relating to the stochastic properties of aggregate consumption and stock market returns, are estimated. One important feature of this approach is that it does not require a complete, explicit representation of the economic environment. Moreover, GMM provides consistent estimates of the relative risk aversion coefficient, α, and the time discount factor, β.

The results indicate that risk aversion of the agents, α, is higher compared to Hansen and Singleton's (1982) results. The value for β, is similar to Hansen and Singleton (1982), it exceeds 0.99, but it is less than unity.

The rest of the study is organized as follows: In Section 2, literature review is presented. In Section 3, Consumption-Based Capital Asset Pricing Model (CCAPM) is explained. In Section 4, data and the estimation model are presented. In Section 5, the results are discussed, and finally in Section 6 some concluding remarks are made.

2 Literature Review

Consumption-based asset pricing models have been investigated extensively in financial economics literature. While initial empirical tests, such as Hansen and Singleton (1983) and Mehra and Prescott (1985), failed to support the model, more recent tests are much more supportive of CCAPM theory (Breeden et al., 2014).

Hansen and Singleton (1982, 1983) proposed a canonical consumption-based capital asset pricing model where representative agent has time-separable power utility of consumption. They rejected the model on US data while Wheatley (1988) rejected the model on international data. However, despite its poor empirical performance, there are some improvements both on the theoretical and the empirical sides.

On the theoretical side, Epstein-Zin (1989) and Weil (1989) have proposed "recursive utility models" which allow for a seperation between risk aversion and intertemporal elasticity of substitution (IES) of investors. These utility functions have attracted significant attention within the macro-finance literature.

Sundaresan (1989), Constantinides (1990) and Ferson and Constantinides (1991) have proposed an "internal habit model". They have argued for the importance of habit formation, a positive affect of today's consumption on tomorrow's marginal utility of consumption. On the other hand, Abel (1990) and Campbell and Cochrane (1999) developed "external habit model". Abel (1990) terms his model "Catching up with the Joneses". In this model, one's utility depends on how one is doing relative to others. In the model of Campbell and Cochrane (1999), habit depends on aggregate consumption and it is not affected by any one agent's decision.

Mankiw and Zeldes (1991) argued that the non-participation phenomenon and pointed out that consumption of stockholders and non-stockholders differs considerably. They stated that estimating the CCAPM using only the aggregate consumption of stockholders results in a lower estimate of the representative risk aversion coefficient.

Heaton and Lucas (1996), Constantinides and Duffie (1996) examined "incomplete markets", that is not all assets may be traded and heterogeneous shocks are not perfectly insurable. In this case, consumers have more volatile consumption streams.

Brav, Constantinides and Geczy (2002) examined the case of asset pricing with heterogeneous agents and limited participation of households and they found generally plausible estimates of relative risk aversion. Vissing-Jorgensen (2002) also address the issue of limited participation. She estimates intertemporal substitution parameters for households holding stock and households holding only bonds. She finds that bondholders have higher coefficients of intertemporal substitution than stockholders.

The canonical CCAPM has been modified including housing in the utility function and in the budget constraint. Piazzesi, Schneider and Tuzel (2005) labeled that as "Housing CCAPM" (HCCAPM). The main idea of this model is that the representative agent not only concerns the consumption volatility, but also the composition risk that is the fluctuation in the relative share of housing service in their consumption basket. They also showed that the non-housing consumption share can be used to predict the stock return.

On the empirical side, there are also studies on examining changes in conditional means, variances and covariances. Lettau and Ludvigson (2001a, 2001b) examined the conditional CCAPM. They divide the aggregate wealth portfolio into two components, financial wealth and human wealth. They find that the consumption-to-wealth ratio rationally predicts stock returns. The performance of the conditional CCAPM can be compared to the Fama-French three factor model.

More recently, Bansal and Yaron (2004) modeled the "long-run risk" caused by volatility of real consumption growth. They showed that the conditional volatility of consumption is time-varying. In the long-run risks model, the preferences developed in Epstein and Zin (1989) play an important role.

Parker and Julliard (2005) showed that it is important to measure "ultimate consumption betas" that is the covariance between an asset's return during a quarter and cumulative consumption growth over the several following quarters, explains the cross-section of stock returns.

Yogo (2006) examined the importance of consumer durables. He found that durable consumption with non-durable consumption can explain the cross-section of stock returns.

Jagannathan and Wang (2007) found that when consumption betas of stocks are computed using year-over-year consumption growth based upon the fourth quarter, the CCAPM explains the cross-section of stock returns.

Bansal, Dittmar and Kiku (2009) showed that systematic consumption risk, if measured over longer horizons, is able to explain cross-sectional variation in expected-return.

Recently, Savov (2010) showed that an alternative measure of consumption, annual garbage generation, is more volatile and more correlated with stocks than the canonical measure.

3 The Consumption-Based Capital Asset Pricing Model

The theoretical development of the consumption-based capital asset pricing model (CCAPM) is accredited to Mark Rubinstein (1976), Robert Lucas (1978), and Douglas Breeden (1979). In this model, the economy is assumed to be populated by a large number of households that are identical in terms of their preferences and endowments. This assumption allows us to characterize outcomes in financial markets and the economy as a whole by examining the behavior of a single, representative consumer. The utility function of the representative agent is defined over current and future values of consumption, C_t and C_{t+1}, where ρ is the subjective discount factor and captures impatience (0<ρ<1).

$$U(C_t, C_{t+1}) = U(C_t) + \rho E_t[U(C_{t+1})] \quad (3.1)$$

For the two dates and one period $(t, t+1)$, the agent's maximization problem is,

$$\max_{z_j} E_t[U(C_t, C_{t+1})] \quad (3.2)$$

subject to:

$$C_t = e_t - z_j P_{jt} \quad (3.3)$$

$$C_{t+1} = e_{t+1} + z_j X_{j,t+1} \quad (3.4)$$

where e represent the original consumption level, z_j is the amount of the asset j that the agent chooses to buy, P_{jt} is the price of the asset j at time t, X_{jt+1} payoff of the asset j at time t+1.

If the constraints are substituted into the objective function

$$\max_{z_j} U[e_t - z_j P_{jt}] + E_t[\rho U(e_{t+1} + z_j X_{j,t+1})] \quad (3.5)$$

and solving for z_j, the standard marginal condition for an optimum is obtained:

$$P_{jt} U'(C_t) = E_t[\rho U'(C_{t+1}) X_{j,t+1})] \; j = 1, ..., N \quad (3.6)$$

Finally, the price for any asset is obatined as,

$$P_{jt} = E_t\left[\rho \frac{U'(C_{t+1})}{U'(C_t)} X_{j,t+1}\right] \; j = 1, ..., N \quad (3.7)$$

This model is characterized by a stochastic discount factor (the intertemporal marginal rate of substitution or the pricing kernel). The stochastic discount factor, M_{t+1}, is the discounted marginal rate of substitution of consumption:

$$M_{t+1} = \rho \frac{U'(C_{t+1})}{U'(C_t)} \tag{3.8}$$

Therefore, (3.7) can be written as:

$$P_{jt} = E_t[M_{t+1} X_{j,t+1}] \; j = 1, ..., N \tag{3.9}$$

which is "the basic pricing equation". Using the definition of covariance,

$$Cov_t(M_{t+1}, X_{j,t+1}) = E_t(M_{t+1}, X_{j,t+1}) - E_t(M_{t+1}) E_t(X_{j,t+1}) \tag{3.10}$$

the basic pricing equation can be restated as:

$$P_{jt} = E_t(M_{t+1}) E_t(X_{j,t+1}) + Cov_t(M_{t+1}, X_{j,t+1}) \tag{3.11}$$

and substituting the risk free rate which is

$$R_{f,t+1} = \frac{1}{E_t[M_{t+1}]} \tag{3.12}$$

following equation is obtained.

$$P_{jt} = \frac{E_t(X_{j,t+1})}{R_{f,t+1}} + Cov_t(M_{t+1}, X_{j,t+1}) \tag{3.13}$$

The first term in (3.13) is the present-value formula in a risk neutral world. The second term is a risk adjustment. If the asset's payoff covaries positively with the discount factor, the asset price rises and vice versa. Using the marginal rate of substitution as the stochastic discount factor, the pricing equation becomes

$$P_{jt} = \frac{E_t(X_{j,t+1})}{R_{f,t+1}} + \frac{Cov_t[\rho U'(C_{t+1}, X_{j,t+1})]}{U'(C_t)} \tag{3.14}$$

Thus, it can be seen from (3.14),

- an asset's price is lowered if its payoff covaries positively with consumption,

- an asset's price is raised if its payoff covaries negatively with consumption.

In order to restate the basic pricing equation, (3.9), in terms of risk and expected return, both sides of the pricing equation is divided by P_{jt},

$$1 = E_t\left[\rho\frac{U'(C_{t+1})}{U'(C_t)}R_{jt+1}\right] \tag{3.15}$$

where the gross rate of return is defined as

$$R_{j,t+1} = \frac{X_{j,t+1}}{P_{jt}} \tag{3.16}$$

and using again the definition of the covariance,

$$E_t\left[\rho\frac{U'(C_{t+1})}{U'(C_t)}\right]E_t(R_{j,t+1}) + Cov_t\left[\rho\frac{U'(C_{t+1})}{U'(C_t)}R_{j,t+1}\right] = 1 \tag{3.17}$$

$$E_t(R_{j,t+1}) = \frac{1}{E_t[\rho\frac{U'(C_{t+1})}{U'(C_t)}]} - \frac{Cov_t[\rho\frac{U'(C_{t+1})}{U'(C_t)}, R_{jt+1}]}{E_t[\rho\frac{U'(C_{t+1})}{U'(C_t)}]} \tag{3.18}$$

Consumption-Based Capital Asset Pricing Model (CCAPM) is obtained:

$$E_t(R_{j,t+1}) = R_{f,t+1} - \frac{Cov_t[U'(C_{t+1}), R_{j,t+1}]}{E_t[U'(C_{t+1)}]} \tag{3.19}$$

Equation (3.19) shows that the risk premium of any asset is a function of the covariance of its return with the stochastic discount factor. Assets whose returns covary positively with the stochastic discount factor will have a negative risk premium, while assets whose returns covary negatively with the stochastic discount factor will have a positive risk premium.

3.1 The Power Utility Function

Asset pricing often uses a power utility form, also called the constant relative risk aversion (CRRA) preferences, where γ represents the relative risk aversion coefficient.

$$U(C_t) = \begin{cases} \frac{(C_t)^{1-\gamma}-1}{1-\gamma} \; if\gamma > 0, \gamma \neq 1 \\ \log(C_t) \; if\gamma = 1 \end{cases} \tag{3.20}$$

The CRRA utility function exhibits decreasing absolute risk aversion, which means that when the initial wealth increases, aversion towards risk diminishes. Wealthy individuals are less averse that poorer ones with regard the same risk. The CRRA utility function exhibits constant relative risk aversion, therefore the proportion of wealth that agents want to expose to risk remains unchanged with wealth.

The power utility function has some important properties (Campbell, 1999). First, it is scale-invariant such that with constant return distributions, the risk premium does not change over time as aggregate wealth and the scale of the economy increase. Second, if different investors in the economy have different wealth levels but the same power utility function, they can be aggregated into a single representative investor.

Under the power utility function, marginal utility $U'(C_t) = (C_t)^{-\gamma}$ and the discount factor depends on the aggregate consumption growth, the relative risk aversion coefficient and the impatience parameter. The stochastic discount factor is:

$$M_{t+1} = \rho \frac{U'(C_{t+1})}{U'(C_t)} = \rho \Big(\frac{C_{t+1}}{C_t} \Big)^{-\gamma} \tag{3.21}$$

If the investor is highly risk averse, the present value of future payoffs will also be low. Thus, the basic pricing equation under power utility is:

$$E_t \Bigg[\rho \Big(\frac{C_{t+1}}{C_t} \Big)^{-\gamma} R_{jt+1} \Bigg] = 1 \tag{3.22}$$

3.2 Linearizing the Model

For simplicity, following Hansen and Singleton (1983), it can be assumed that joint conditional distribution of asset returns and the stochastic discount factor is lognormal and homoskedastic (Campbell, 1999). Assuming that aggregate consumption is conditionally lognormal, equation (3.23) is obtained

$$r_{f,t+1} = -\ln\rho + \gamma E_t[\Delta c_{t+1}] - \frac{\gamma^2}{2}\sigma_c^2 \tag{3.23}$$

It says that there is a linear relationship between the riskless real rate and expected consumption growth while the slope coefficient is the coefficient of relative risk aversion. The conditional variance of consumption growth has a negative effect on the riskless real rate.

$$E_t[r_{j,t+1} - r_{f,t+1}] + \frac{\sigma_j^2}{2} = \gamma\sigma_{jc} \tag{3.24}$$

where $\sigma_j^2 = Var_t(r_{j,t+1})$ and $\sigma_{jc} = Cov_t(r_{j,t+1}, \Delta c_{t+1})$.

The left-hand side adjustment is a Jensen's inequality correction that can be eliminated and therefore it can be stated as

$$E_t[R_{j,t+1}] - R_{f,t+1} \cong \gamma\sigma_{jc} \tag{3.25}$$

The basic pricing model with power utility implies the risk premium on any asset is linear and positively related with the covariance of the return with the consumption growth where the slope is the relative risk aversion coefficient of the representative investor. This shows that an asset whose payoff covaries positively with consumption growth make consumption more volatile and must promise higher expected excess returns. Moreover, the expected excess return will be higher if the representative investor is more risk averse.

4 Data and Methodology

4.1 Data

In this empirical study, two different measures of consumption are considered, as in Hansen and Singleton (1982): nondurables (ND) and nondurables plus services (NDS). The seasonally adjusted series of nondurables and services for the period between February 1959 and February 2015 are obtained from the FRED (Federal Reserve Economic Data) database. Frequency of the series is monthly. In order to obtain real per capita aggregate consumption series, each observation of these series are divided by the corresponding observation on population which is also obtained from the FRED database.

The second data set is real return of $S\&P500$. Price index of $S\&P500$ for the same period are obtained from Yahoo Finance. The series of the historical prices of the $S\&P500$ already contains information related to dividends. Following formula is used to calculate the returns;

$$r = \frac{P_{t+1} + D_{t+1} - P_t}{P_t} \tag{4.1}$$

$$r + 1 = \frac{P_{t+1} + D_{t+1}}{P_t} \tag{4.2}$$

where r is return, P_t is price at time t, P_{t+1} is price at time $t+1$ and D_{t+1} is dividend paid at time $t+1$.

Descriptive statistics and plot of the gross return are showed in Figure 4.1 and 4.2, respectively.

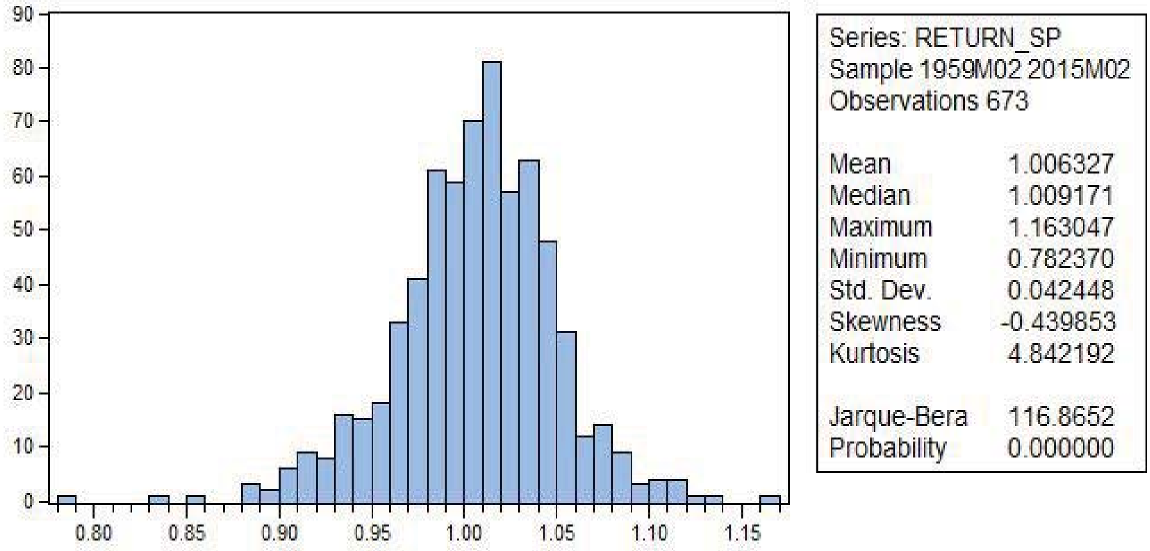

Figure 4.1: $S\&P500$ Gross Return

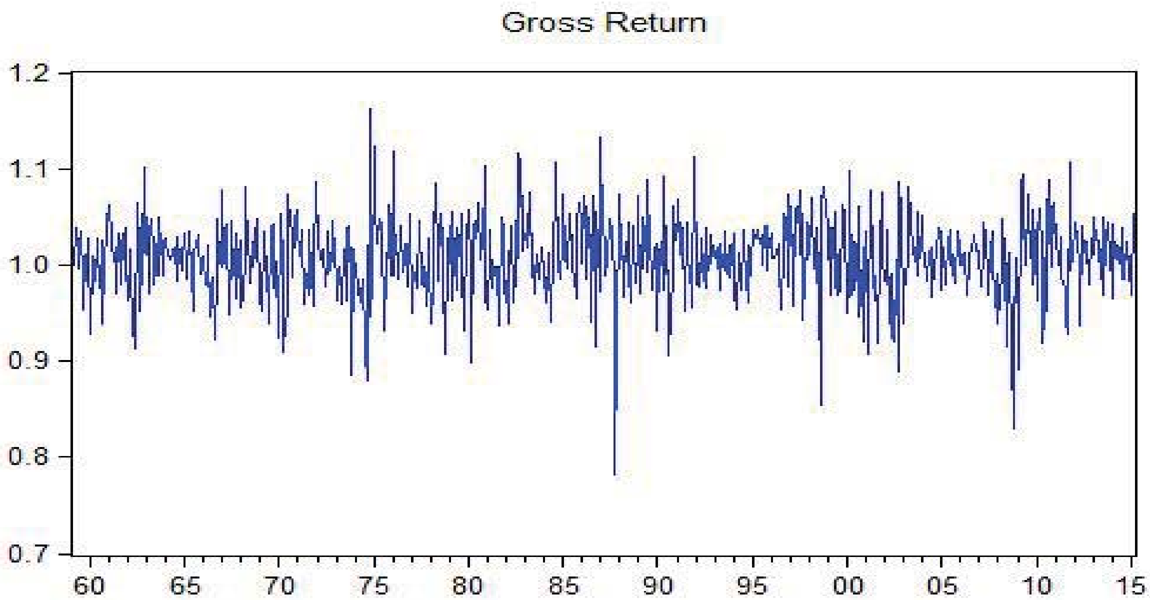

Figure 4.2: Gross Return on $S\&P500$, 1959-2015

4.2 GMM Estimation

For the estimation, Generalized Method of Moments (GMM) methodology is implemented in MATLAB.

GMM is developed by Hansen in 1982 as a generalization of method of moments and since then it has had a major impact on empirical research in finance. It is currently applied in numerous fields including international finance, finance and macroeconomics. One important advantage of GMM is that it requires less restrictive assumptions than those needed for maximum likelihood estimation. GMM let us to test the CCAPM without making distributional assumptions. However, despite its advantages, GMM has a potential shortcoming when compared to the maximum likelihood method. When the distributional assumptions are valid, the maximum likelihood method provides the most efficient estimates, whereas the GMM method may not (Jagannathan et al., 2002).

GMM is particularly useful in estimating the parameters of nonlinear models. Hansen and Singleton (1982) estimate the parameters corresponds to impatience of an individual, β, and a measure of risk aversion, α, of the consumption model using the GMM. Following overview follows Hansen and Singleton (1982).

The representative consumer's maximization problem

$$max\ E_0\Big[\sum_{t=0}^{\infty}\beta^t U(C_t)\Big] \tag{4.3}$$

$$s.t.\ C_t + \sum_{j=1}^{N} P_{jt}Q_{jt} \leq \sum_{j=1}^{N} R_{jt}Q_{jt-M_j} + W_t\ (j = 1, ..., N). \tag{4.4}$$

where U(.) is a strictly concave function and

β: Discount factor and $\beta \in (0,1)$

C_t: Consumption at time period t

P_{jt}: Price of asset j at date t

Q_{jt}: Quantity of asset j held at the end of date t

R_{jt}: Date t payoff from holding a unit of an M_j period asset purchased at date $t - M_j$

W_t: Labor income at date t

M_j: Asset maturity

The first-order necessary conditions for N given assets are:

$$P_{jt}U'(C_t) = \beta^{M_j} E_t[(R_{jt+M_j}U'(C_{t+M_j})] \ (j = 1, ..., N). \tag{4.5}$$

These conditions are used by Hansen and Singleton (1982) to construct the orthogonality conditions.

By the assumption, preferences are described by a vector of parameters γ, U(.γ). Since C_t and P_{jt} are known to agents at time t, then (4.4) implies:

$$E_t\Big[\beta^{n_j}\frac{U'(C_{t+n_j},\gamma)}{U'(C_t,\gamma)}x_{jt+n_j} - 1\Big] = 0 \tag{4.6}$$

where $x_{jt+n_j}= R_{n_jt+n_j}/P_{n_jt}$ for $j = 1, ..., m$. (m $\leq$ N)

The orthogonality conditions are:

$$h(x_{t+n}, b_0) = \begin{bmatrix} \beta^{n_1}\frac{U'(C_{t+n_1},\gamma)}{U'(C_t,\gamma)}x_{1t+n_1} - 1 \\ \vdots \\ \beta^{n}\frac{U'(C_{t+n},\gamma)}{U'(C_t,\gamma)}x_{mt+n} - 1 \end{bmatrix} \tag{4.7}$$

with $x_{jt+n_j}= (P_{jt+n_j} + D_{jt+n_j})/P_{n_jt}$.

For illustrative purposes , Hansen and Singleton (1982) assume that preferences are of the constant relative risk averse type,

$$U(C_t) = \frac{(C_t)^\gamma}{\gamma},\ \gamma < 1. \tag{4.8}$$

In this case, the marginal utility is given by

$$U'(C_t) = (C_t)^\alpha,\ \alpha \equiv \gamma - 1. \tag{4.9}$$

If the m assets are stocks, then (4.5) can be simplified to:

$$E_t[\beta(x_{kt+1})^\alpha x_{jt+1}] = 1,\ (j = 1, ..., m.) \tag{4.10}$$

where x_{kt+1} is the ratio of consumption in time period $t+1$ to consumption in time period t, and the one-period real return x_{jt+1} is given by $(P_{jt+1} + D_{jt+1})/P_{jt}$.

Therefore, the orthogonality conditions are constructed using:

$$h(x_{t+1}, b_0) = \beta\Big(\frac{C_{t+1}}{C_t}\Big)^\alpha \Big(\frac{P_{1t+1} + D_{1t+1}}{P_{1t}}\Big) - 1 \tag{4.11}$$

where $b_0 = (\alpha, \beta)$.

In order to estimate the vector b_0 using a generalized instrumental variables procedure, the orthogonality conditions can be written more compactly as follows.

The first order conditions:

$$E_t[h(x_{t+1}, b_0)] = 0 \tag{4.12}$$

Function f is defined as

$$f(x_{t+n}, z_t, b) = h(x_{t+1}, b) \otimes z_t \tag{4.13}$$

where z_t denote a q dimensional vector of variables with finite second moments that are in agents' information set and they are observable, $\otimes$ is the Kronecker product. The vector of instruments z_t is formed using lagged values of x_{t+1}.

NLAG is chosen to be 1.

It can be written as

$$E[f(x_{t+n}, z_t, b_0)] = 0 \tag{4.14}$$

The sample average of $f(x_{t+n}, z_t, b)$ is

$$g_T(b) = \frac{1}{T}\sum_{1}^{T} f(x_{t+n}, z_t, b) \tag{4.15}$$

and the GMM estimate $\widehat{b_t}$ is obtained by minimizing the quadratic function

$$J_T = [g_T(b)]' W_T [g_T(b)]. \tag{4.16}$$

where W_T is an symmetric, positive definite matrix that an depend on sample information. In this study, in order to simplify the estimation, the identity matrix is used as weighting matrix.

5 Results

As an application of the generalized instrumental variables estimator, the parameters of preferences, α and β are estimated. The estimates are shown in Table 5.1. There is no risk premium puzzle since there is no risk-free rate.

The results show that the risk aversion is negative though theory suggest it is positive. The estimates of α range from -0.2846 and -0.7005. The estimated standard error for α, is smaller when consumption is measured as ND than when consumption is measured as NDS.

The estimates of β range from 0.9930 and 0.9952. The estimated standard error for β, is smaller when consumption is measured as ND than when consumption is measured as NDS. As expected, the values of β exceeds 0.99 but are less than unity.

Comparing to the results obtained by Hansen and Singleton (1982) the values of the α are much higher which implies that risk aversion is higher. On the other hand, the value for β, is similar to Hansen and Singleton (1982), exceed 0.99, but it is less than unity.

Table 5.1: IV Estimates for the Period 1959:2-2015:2

Cons	Return	NLAG	$\hat{\alpha}$	SE($\hat{\alpha}$)	$\hat{\beta}$	SE($\hat{\beta}$)
ND	$S\&P500$	1	-0.2846	0.1706	0.9930	0.0016
NDS	$S\&P500$	1	-0.7005	0.3616	0.9952	0.0022

Table 5.2: IV Estimates for the Period 1959:2-1978:12, Hansen and Singleton

Cons	Return	NLAG	$\hat{\alpha}$	SE($\hat{\alpha}$)	$\hat{\beta}$	SE($\hat{\beta}$)	χ^2	Prob
ND	EWR	1	-0.9737	0.1245	0.9922	0.0031	5.9697	.9854
ND	VWR	1	-0.8985	0.1057	0.9971	0.0025	1.5415	.8756
NDS	EWR	1	-0.9457	0.3355	0.9931	0.0031	4.9994	.9746
NDS	VWR	1	-0.9001	0.3130	0.9979	0.0025	1.1547	.7174

6 Conclusion

In this study, I empirically investigate the parameters of economic agents' dynamic objective functions, which are the time discount factor, β, and the relative risk aversion coefficient, α.

Two different measures of consumption are considered: nondurables (ND) and nondurables plus services (NDS) for the period between February 1959 and February 2015. Comparing to the results obtained by Hansen and Singleton (1982), I obtained higher values for α, and similar values for β.

Possible extension of this study can be conducted with whole range lagged values and Hansen matrix.

Bibliography

[1] Abel, A.B., 1990. Asset Prices Under Habit Formation and Catching up with the Joneses, *American Economic Review Papers and Proceedings*, 80, pp.38-42.

[2] Bansal, R. & Yaron A., 2004. Risks for the long run: A potential resolution of asset pricing puzzles, *Journal of Finance*, 59(4), pp.1481-1509.

[3] Bansal, R., Dittmar R. & Kiku D., 2009. Cointegration and Consumption Risks in Asset Returns, *Review of Financial Studies*, 22(3), pp.1343-1375.

[4] Breeden, D.T., 1979. An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities, *Journal of Financial Economis*, 7, pp.265-296.

[5] Breeden, D.T., Gibbons M.R. & Litzenberger R.H., 1989. Empirical Tests of the Consumption-oriented CAPM, *Journal of Finance*, 44(2), pp.231-262.

[6] Breeden, D.T., Litzenberger, R.H. & Jia, T., 2014. Consumption-Based Asset Pricing: Research and Applications, *Annual Review of Financial Economics*, Vol. 7: (Volume publication date November 2015).

[7] Campbell, J., 1999. Asset Prices, Consumption and the Business Cycle, in John Taylor and Michael Woodford, eds., *Handbook of Macroeconomics*, Volume I, Amsterdam: North-Holland.

[8] Campbell J.Y. & Cochrane, J.H., 1999. By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior, *Journal of Political Economy*, 107, pp.205-251.

[9] Constantinides, G., 1990. Habit Formation: A Resolution of the Equity Premium Puzzle, *Journal of Political Economy*, 98, pp.519-543.

[10] Epstein, L.G. & Zin, S.E., 1989. Substitution, Risk Aversion and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework, *Econometrica*, 57, pp.937-968.

[11] Ferson, W.E. & Constantinides, G.M., 1991. Habit Persistence and Durability in Aggregate Consumption: Empirical Tests, *Journal of Financial Economics*, 29, pp.199-240.

[12] Grossman S.J., Melino A. & Schiller R.J., 1987. Estimating the Continuous-time Consumption-Based Asset Pricing Model, *Journal of Business and Economic Statistics*, 5(3), pp.315-327.

[13] Hansen, L. P. & Singleton, K.J., 1982. Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Model, *Econometrica*, vol. 50, issue 5, pp.1269-86.

[14] Hansen, L. P. & Singleton, K.J., 1983. Stochastic Consumption, Risk Aversion and the Temporal Behavior of Asset Returns, *Journal of Political Economy*, 91, pp.249-268.

[15] Hansen, L. P. & Jagannathan, R., 1991. Implications of Security Market Data for Models of Dynamic Economies, *Journal of Political Economy*, 99, pp.225-262.

[16] Jagannathan, R. & Wang, Y. 2007. Lazy Investors, Discretionary Consumption, and the Cross-Section of stock Returns, *Journal of Finance*, 62(4), pp.1623-1661.

[17] Jagannathan, R., Skoulakis, G. & Wang, Z., 2002. Generalized Method of Moments: Applications in Finance, *Journal of Business and Economic Statistics*, 20, pp.470-481.

[18] Kocherlakota N., 1996. The Equity Premium: It's still a Puzzle, *Journal of Economic Literature*, 34, pp.42-71.

[19] Lucas, R.E., 1978. Asset Prices in an Exchange Economy, *Econometrica*, 46, pp.1429-45.

[20] Lettau M. & Ludvigson S.C., 2001. Consumption, Aggregate Wealth, and Expected Stock Returns, *Journal of Finance*, 56(3), pp.815-849.

[21] Lettau M. & Ludvigson S.C., 2001. Resurrecting the (C)CAPM: A Cross Sectional Test When Risk Premia are Time-varying, *Journal of Political Economy*, 109(6), pp.1238-1287.

[22] Mankiw N.G. & Zeldes S.P., 1991. The Consumption of Stockholders and Nonstockholders, *Journal of Financial Economics*, 29(1), pp.97-112.

[23] Marcet A. & Marshall D., 1994. Solving Nonlinear Rational Expectations Models by Parameterized Expectations: convergence to Stationary Solutions, *Working Paper Series, Macroeconomic Issues*, 94-20, Federal Reserve Bank of Chicago.

[24] Mehra R. & Prescott, E.C., 1985. The Equity Premium Puzzle, *Journal of Monetary Economics*, 15, pp.145-161.

[25] Rubinstein, M., 1976. The Valuation of Uncertain Income Streams and the Pricing of Options, *Bell Journal of Economics and Management Science*, 7, pp.407-425.

[26] Sundaresan, S. M., 1989. Intertemporally Dependent Preferences and the Volatility of Consumption and Wealth, *Review of Financial Studies*, 2, pp.73-88.

[27] Weil, P., 1989. The Equity Premium Puzzle and the Risk-Free Rate Puzzle, *Journal of Monetary Economics*, 24, pp.401-421.

[28] Wheatley, S., *1988, Some Tests of the Consumption-Based Asset Pricing Model*, Journal of Monetary Economics, 22(2), 193-215.