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Aggregate Consumption and the Risk Free Rates in Turkey: An Empirical Analysis

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Abstract: The empirical work using the aggregate data from developed countries has been rejected the consumption based capital asset pricing model (C-CPAM). This paper attempts to test C-CPAM using Turkish aggregate data. The nonlinear Euler equation from C-CPAM with a single risk-free asset is estimated by GMM estimation procedure using different measures of consumption and rate of return. In all estimations, the overidentification restrictions are failed to reject, and the estimations of the preference parameters are significant.

Keywords: C-CPAM, Euler equation, consumption, risk-free rate, GMM.

Türkiye'de Toplam Tüketim ve Risksiz Faiz Oranları: Ampirik bir Analiz

Özet: Gelişmiş ülkelerin toplulaştırılmış verilerini kullanan ekonometrik çalışmalar tüketim temelli sermaye varlıkları fiyatlandırma (Consumption based Capital Asset Pricing - C-CAP) modelini reddetmişlerdir. Bu çalışma toplulaştırılmış veri kullanarak C-CAP modelini Türkiye için test etmeyi amaçlamaktadır. Sadece risksiz bir sermaye varlığının yer aldığı bir C-CAP modelinden elde edilen doğrusal olmayan Euler denklemi, farklı tüketim ve getiri oranları kullanılarak GMM yöntemi ile tahmin edilmiştir. Tahminlerin hiçbirinde aşırı belirlenme kısıtları reddedilmemiştir ve tercih parametreleri istatistiksel olarak anlamlı bulunmuştur.

Anahtar Kelimeler: C-CPAM, Euler denklemi, tüketim, faiz oranları, GMM.

Introduction

The aggregate consumption behavior with respect to changes in the expected rate of return on financial assets predicted by the consumption based capital asset pricing models (C-CAPM) has been rejected constantly by the data (e.g. Mankiw, 1981; Hansen and Singleton, 1982;1983;1996; Summers, 1984; Mankiw, Rosenberg and Summers,1985). This result has opened a new avenue of research on the possible causes of the failure of C-CPAM. Much of the work in this literature is on developed countries with sound financial systems. In developing countries with relatively weak and fragile financial systems, as in the case of Turkey, real rates of return on capital assets and the consumption volatility are, in general, higher than those of developed countries (Köse, Pradas and Terrones, 2003). Therefore, it may be of interest to see whether the predictions of C-CPAM would make sense for developing countries.

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The early work of Hansen and Singleton (1982) attempted to test the implications of C-CAPM directly by means of the nonlinear Euler equations obtained from the first order conditions of the representative agent's optimization problem. Using monthly post-war U.S. aggregate data, the authors estimated the preference parameters using the generalized method of moments (GMM) estimator. They used the aggregate consumption expenditure, Treasury bills and stock market data, and rejected overidentifying restrictions, suggesting against the C-CPAM approach. Possible resolutions for this failure of C-CPAM suggested by the later work on the subject includes the modification of the model, alternative measures for consumption and more efficient techniques of estimation.

Following GMM approach of Hansen and Singleton (1982), this paper attempts to estimate the preference parameters, namely the coefficient of relative risk aversion (CRRA) and the coefficient of intertemporal elasticity of substitution (IES) using aggregate Turkish data for the period 1987-2005. The overidentification tests are also performed in order to see whether the data rejects the model.

GMM estimation procedure is particularly suitable for estimating the nonlinear Euler equations obtained from the first order conditions of the representative agent's optimization problem, and testing the overidenfying restrictions. This estimation procedure exploits the nonlinear moment conditions implied by the model to obtain the estimations of the structural parameters.

The paper is organized as follows. The next section describes the economic model and the moment condition used for estimation. Section three discusses some data issues and Section four presents the estimation results. The last section provides a brief summary of the results.

Economic Model and Methodology

The economic model considered is a standard representative agent C-CAPM of Hansen and Singleton (1982) with a single risk-free asset and time-separable preferences. The representative household aims to maximize the expected value of her lifetime utility by choosing a stochastic consumption plan $\{c_t\}_{t=0}^{\infty}$:

$$E_0\left[\sum_{t=0}^{\infty}\beta u(c_t)\right], \qquad 0<\beta<1 \tag{1}$$

In the above expression, β is the subjective discount factor, and E_t is the expectations operator conditioned on the information available at time *t*. The period utility function $u(c_t)$ is assumed to have the following isoelastic form:

$$u(c_t) = \frac{c_t^{1-\gamma}}{1-\gamma}, \qquad \gamma > 0, \ \gamma \neq 1 \tag{2}$$

where c_t is the agent's period t consumption, and γ is the coefficient of relative risk aversion which is also the inverse of the coefficient of intertemporal elasticity of substitution σ. The representative household stores her wealth in the form of a single risk-free asset which pays only an interest, in the unit of the consumption good, in return for holding the asset for one period. Let a_t and r_t denote the risk-free asset holdings and the rate of return on the risk-free asset held for one period, from period (*t-1*) to period (*t*). The agent also earns a labor income y_t by supplying her one unit of labor at period *t* inelastically. Then the representative agent's budget constraint can be written as,

$$c_t + a_{t+1} \leq (1+r_t)a_t + y_t \tag{3}$$

The first order condition from maximizing (1) with respect to (3) gives the following Euler equation:

$$E_t\left[\beta\left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}(1+r_{t+1})\right] = 1 \tag{4}$$

Hansen and Singleton (1982) showed that the structural parameters of the model given by Equations (1), (2) and (3) can be estimated from the nonlinear Euler equation (5) by GMM estimation technique. The main advantage of GMM estimation is that, unlike the maximum likelihood estimation, it does not require any distributional assumptions on the residual terms. This estimation technique makes use of the moment conditions (or orthogonality conditions) implied by an economic model to estimate the structural parameters. In our case the moment condition for the GMM estimator can be obtained by rearranging Equation (1):

$$E_t\left[\beta\left(\frac{c_{t+1}}{c_t}\right)^{-\gamma}(1+r_{t+1}) - 1\right] = 0 \tag{5}$$

The estimation procedure allows us to perform specification tests to assess whether the Turkish data rejects the model. This can be done by testing the overidentifying restrictions of the model. Hansen (1982) suggested a simple way of testing the overidentifying restrictions. For the overidentifying restrictions to be valid, the inclusion of an additional instrument into the estimated model should not increase the value of so called '*J* statistic.' *J* statistic, under the null hypothesis, is asymptotically distributed as χ^2 with (qm-r) degrees of freedom, where q is the number of equations, m is the number of instruments, and r is the number of parameters estimated (Hansen, 1982). The null hypothesis for the *J*-test is that 'the moment conditions hold,' (i.e. overidentifying restrictions accepted by the data). The rejection of the null provides evidence for misspecification of the econometric model estimated, as well as the underlying economic model from which the Euler equation is obtained.

Data

Most of the previous work on U.S. data including Hansen and Singleton (1992;1984;1996) and Epstein and Zin (1991) employed monthly series, since it is more likely to capture the timing of agent's decisions. The choice of the data frequency is important for econometric practice. Using monthly or quarterly data instead of annual, for instance, could make a difference in terms of definitions of durable and non-durable goods. A consumption good defined as durable in quarterly data could be non-durable in the annual data, because it depreciates fully in a year rather than a quarter or a month. Another issue is related to the consumers' decision period and the data frequency used for estimation. If the decision period of consumers is shorter than the data frequency used in the study, one might expect measurement errors in the data. On the other hand, using a lower frequency model than the sampling period will introduce a moving average component to the data (Hall, 1988; Hansen and Singleton, 1996).

Using quarterly data was the only available option for the present study. The 3 month T-bill series are not available for the period before 1987. Consequently, the number of observations (18) in the annual series is not sufficient for the estimation. On the other hand, there is simply no monthly aggregate consumption expenditure series available for Turkey. Therefore the model is estimated using quarterly data covering the period 1987:1 to 2005:3.

The quarterly aggregate private consumption expenditure series have been extracted from the National Accounts tables of SIS (State Institute of Statistics). All series are quarterly, and in real terms (in 1987 prices). Most of the previous work on the field considered non-durable consumption expenditure plus services as the measure of consumption, and ignored the durable goods expenditure[1]. The idea behind this is that the representative

[1] Ogaki and Reinhart (1998) investigated the role of durable goods expenditure in intertemporal substitution.

consumer gains utility from the service flow provided by the durable goods, not from the purchase of them. Since it is difficult to account for the service flow generated by durable goods, following the previous studies, this paper considers only non-durable consumption and services. There are two different non-durable goods definitions in the national accounts of Turkey: food and beverages; semi and non-durable goods. Two different private consumption measures are considered for the empirical analysis:

CSN = semi and non-durables

CN = food and beverages + services + semi and non-durables

All consumption series are seasonally adjusted by TRAMO/SEATS method, and divided by population to obtain the per capita consumption. Some authors (Miron, 1986; English, Miron and Wilcox, 1989) argued against the seasonal adjustment of the consumption expenditure series. They suggest that the seasonal adjustment procedures such as X11 introduces spurious serial correlation into the error term which might be a potential cause for the rejection of the model. Ferson and Harvey (1992), however, report that the use of seasonally unadjusted data makes no difference regarding the rejection of the C-CPAM. Hence the present paper employs seasonally adjusted data in all estimations.

For the rate of return variable two different interest rates are considered: 3-month Treasury bills and 3-month deposits on banks. Both interest rate series are obtained from CBRT data dissemination system. The quarterly simple nominal interest rate series on the 3-month T-bills sold by auctions have been constructed from the original monthly series by taking the averages of three months where available. In some months there were more than one auction, while in some there was no auctions held. For the missing values in the monthly 3-month T-bills series, 6-month T-bills series have been regressed on 3-month T-bills, and the 3-month rates, if there is a corresponding 6-month rate available, computed by the estimated equation from the regression. The remaining values are interpolated using cubic spline method. The realized real rate of return figures for both return series are computed by Fisher's equation using the implicit deflator associated with the measure of consumption.[1]

It is widely accepted that capital taxes and intertemporal substitution are closely related (e.g. see Summers, 1984; King and Rebelo, 1990). Indeed much of the literature on estimating IES considers after-tax (net) real returns. In the sample period considered the effective marginal capital tax rate on T-bills is zero except for the period between the fourth quarter of 1996 and the

[1] Implicit deflators are also obtained from the seasonally adjusted consumption series.

third quarter of 1998. In this period several marginal tax rates were implemented. All taxes are subtracted from the original monthly series of T-bill rates, and then quarterly series are obtained. The data on bank deposits rates are already in after-tax terms, although nominal.

Estimation and Empirical Results

GMM estimation technique requires all variables be stationary. Hence, before getting to the estimation stage, the stationarity of the consumption growth and real return series need to be checked. Augmented Dickey Fuller (ADF) unit root tests reveal no indication of a stochastic trend in the variables of interest (Table 1).

Table 1. Augmented Dickey-Fuller Unit Root Test Results

Variable	Lags*	ADF test statistic	Critical value (1%)
CSN	0	-10.058***	-3.522
CN	0	-9.455***	-3.522
Return on T-bill	0	-8.218***	-3.522
Return on Deposits	1	-4.603***	-3.524

* Lag lengths are chosen by SIC.
'*******' denotes the rejection of the null at 1% significance level.

In the estimation procedure, three different instrument sets, consisting of a constant and the lagged values of consumption growth and real return measures, are considered. As suggested by Hall (1988), all instruments are lagged at least two periods to deal with possible time aggregation problems. Instrument sets utilized for the estimations are defined as follows:

Instrument Sets:

I1: constant, (c_{t+1}/c_t) lagged 2 to 3, r_{t+1} lagged 2 to 3.

I2: constant, (c_{t+1}/c_t) lagged 2 to 4, r_{t+1} lagged 2 to 4.

I3: constant, (c_{t+1}/c_t) lagged 2 to 5, r_{t+1} lagged 2 to 5.

Table 2. Semi and non-durable consumption and interest rate on deposits

Instrument	Lags	β	γ	σ	*J*-Stat
I1	1	**0.994*** **	**0.707*** **	**1.414**	**3.283**
		(0.006)	(0.297)		(0.350)
	2	**0.994*** **	**0.688*** **	**1.453**	**2.927**
		(0.007)	(0.258)		(0.403)
	4	**0.993*** **	**0.741*** **	**1.350**	**2.682**
		(0.007)	(0.201)		(0.443)
I2	1	**0.988*** **	**0.877*** **	**1.140**	**8.016**
		(0.006)	(0.308)		(0.155)
	2	**0.982*** **	**0.820*** **	**1.220**	**8.782**
		(0.006)	(0.271)		(0.118)
	4	**0.982*** **	**0.934*** **	**1.071**	**6.864**
		(0.006)	(0.194)		(0.231)
I3	1	**0.988*** **	**0.904*** **	**1.106**	**9.427**
		(0.006)	(0.280)		(0.223)
	2	**0.981*** **	**0.732*** **	**1.366**	**10.40**
		(0.006)	(0.234)		(0.167)
	4	**0.982*** **	**0.810*** **	**1.235**	**8.611**
		(0.006)	(0.179)		(0.282)

‘ * ’, **‘**’** and **‘***’** denote 10%, 5% and 1% significance levels respectively. The standard errors are given in parentheses. The numbers in parentheses at the last column are the significance levels.

The estimation results are reported in Tables 2-5. The second column in Tables 2-5 shows the lags allowed for serial correlation. Last column in Tables 2-5 reports *J*-statistics and corresponding P-values in parentheses. The column in Table 2-5 with σ reports the corresponding IES values ($\sigma = 1/\gamma$). All estimations are performed using Newey-West automatic bandwidth selection procedure.[1] First of all, it should be noted that the estimated parameters with the instrument set consisting of a constant, (c_{t+1}/c_t) and r_{t+1} lagged two periods are not significant at the conventional levels of significance, although they are not very different in magnitude from the estimations with I1. These estimations are not reported.

[1] See Hall (2005:82) and Matyas (1999:ch.3) for the details of wieghting matrix kernel.

Table 3. Semi and non-durable consumption and 3 month T-bill rate

Instrument Set	Lags	β	γ	σ	*J*-Stat
I1	1	**0.965*****	**0.707*****	**1.414**	**5.601**
		(0.007)	(0.29)		(0.133)
	2	**0.964*****	**0.724*****	**1.381**	**4.769**
		(0.007)	(0.262)		(0.190)
	4	**0.964*****	**0.801*****	**1.248**	**3.931**
		(0.008)	(0.198)		(0.269)
I2	1	**0.962*****	**0.801*****	**1.248**	**7.924**
		(0.007)	(0.295)		(0.16)
	2	**0.958*****	**0.793*****	**1.261**	**7.445**
		(0.007)	(0.267)		(0.19)
	4	**0.958*****	**0.921*****	**1.086**	**6.281**
		(0.008)	(0.196)		(0.280)
I3	1	**0.959*****	**0.779*****	**1.284**	**11.01**
		(0.007)	(0.254)		(0.138)
	2	**0.952*****	**0.696*****	**1.437**	**9.96**
		(0.007)	(0.223)		(0.191)
	4	**0.948*****	**0.777*****	**1.287**	**8.393**
		(0.007)	(0.180)		(0.299)

‘ * ’, **‘**’** and **‘***’** denote 10%, 5% and 1% significance levels respectively. The standard errors are given in parentheses. The numbers in parentheses at the last column are the significance levels.

All the parameter estimations with CSN are significant at 1% level, and the overidentifying restrictions are not rejected at the conventional levels of significance (Tables 3,4). The estimations for IES range from 1.07 to 1.45 with the median value of 1.27. They do not change substantially with the choice of the rate of return measure. The estimates for the subjective discount rate are smaller when T-bill rate is used for the measure of return. This is sensible because of the difference in the average returns on T-bills and on the average returns on term deposits. Notice that $\beta = (1+\rho)^{-1}$, where ρ is the rate of time preference. The economic model employed here requires the rate of time preference be equal to the rate of return in the steady state. The average real rate of return on T-bills is approximately 14% annually in the sample period. This requires the subjective discount rate be around 0.96, which is very close to the estimated values in Table 3. On the other hand the average real rate of return on term deposits is 2% annually in simple terms requiring a discount rate of around 0.99.

Table 4. Food, Services, Semi and Non-durable Consumption and Interest Rate on Term Deposits

Instrument	Lags	β	γ	σ	*J*-Stat
I1	1	**0.995***** (0.006)	**1.628*** (0.909)	**0.614**	**1.645** (0.649)
	2	**0.995***** (0.007)	**1.688*** (0.906)	**0.592**	**1.386** (0.709)
	4	**0.995***** (0.007)	**1.931***** (0.804)	**0.518**	**1.157** (0.763)
I2	1	**0.993***** (0.006)	**0.969** (0.682)	**1.032**	**4.619** (0.464)
	2	**0.993***** (0.006)	**1.009*** (0.643)	**0.991**	**3.959** (0.555)
	4	**0.992***** (0.006)	**1.539***** (0.571)	**0.650**	**3.512** (0.622)
I3	1	**0.991***** (0.006)	**1.247***** (0.522)	**0.802**	**7.851** (0.346)
	2	**0.990***** (0.006)	**1.189***** (0.470)	**0.841**	**6.240** (0.512)
	4	**0.989***** (0.006)	**1.484***** (0.406)	**0.674**	**4.647** (0.703)

‘ * ’, **‘**’** and **‘***’** denote 10%, 5% and 1% significance levels respectively. The standard errors are given in parentheses. The numbers in parentheses at the last column are the significance levels.

Table 4 and 5 reports the estimation results, when the CN variable is employed as the consumption measure. There is a notable difference in the IES estimations from the case where CSN is used. When food consumption and services are added to the semi and non-durable consumption, smaller parameter estimations are obtained for IES. The estimated values for IES range from 0.42 to 1.03 with the median value of 0.60. Moreover the standard errors are somewhat higher than in the CSN case. Even though both consumption measures are closely related, to the author, it is reasonable to think that semi and non-durable consumption are more sensitive than food and services consumption to expected changes in real interest rates. In Tables 4 and 5, the overidentifying restrictions are not rejected.

Table 5. Food, Services, Semi and Non-durable Consumption and 3 Month T-bill Rate

Instrument Set	Lags	β	γ	σ	*J*-Stat
I1	1	**0.967*** **	**1.870** **	**0.535**	**2.814**
		(0.007)	(0.899)		(0.421)
	2	**0.968*** **	**1.980** **	**0.505**	**2.467**
		(0.008)	(0.860)		(0.481)
	4	**0.969*** **	**2.360*** **	**0.424**	**1.864**
		(0.009)	(0.711)		(0.601)
I2	1	**0.961*** **	**1.448** **	**0.691**	**5.789**
		(0.006)	(0.725)		(0.327)
	2	**0.959*** **	**1.526** **	**0.655**	**5.326**
		(0.007)	(0.673)		(0.377)
	4	**0.955*** **	**2.170*** **	**0.461**	**4.268**
		(0.007)	(0.510)		(0.512)
I3	1	**0.961*** **	**1.690*** **	**0.592**	**7.721**
		(0.006)	(0.633)		(0.358)
	2	**0.961*** **	**1.760*** **	**0.568**	**6.532**
		(0.007)	(0.593)		(0.479)
	4	**0.956*** **	**2.067*** **	**0.484**	**5.167**
		(0.007)	(0.468)		(0.640)

' * ', **'**'** and **'***'** denote 10%, 5% and 1% significance levels respectively.
The standard errors are given in parentheses. The numbers in parentheses at the last column are significance levels.

Conclusion

Using the quarterly aggregate data of Turkey, this paper has attempted to estimate the preference parameters, and to test the overidenfying restrictions imposed by the standard C-CPAM with power utility. The estimations of the subjective discount rate, CRRA, and the coefficient of IES have turned out to be significant at 1% level except for a few cases. The estimated values of IES coefficient range from 0.42 to 1.45, and are definitely different from zero. Moreover, there has been no indication of the rejection of the overidentifying restrictions in contrast to the findings of the research on US and UK cases.

The estimation results seem to be more sensitive to the choice of consumption measure than the choice of instrument set. They are also robust to the choice of the rate of return measure. The estimated subjective discount rate parameters are within the expected range and have high significance levels as in previous studies in the literature.

The estimated IES coefficients may be enlightening about the link between the aggregate behavior of consumption and the interest rates in Turkey. The estimations of CRRA, on the other hand, require more cautious interpretation. As Hall (1988) argues, the CRRA estimations may not imply anything about the relative risk aversion of the consumers, since no risky asset has been included in the analysis.

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