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Capital Asset Pricing Model: An Application in Borsa İstanbul

Prof. Dr. Cengiz TORAMAN
Department of Business Administration, Gaziantep University, Gaziantep/Turkey
Email: ctoraman@gantep.edu.tr

Meryem GÜL
Instructor, Vocational School of Düziçi, Osmaniye Korkut Ata University, Osmaniye/Turkey

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Abstract
In this study, the betas and the return ratios of 8 banks operating in Borsa Istanbul between 31.12.2004-31.12.2015 are calculated. Moreover, based on the 2008 crisis, it was tested whether there is a relationship between beta values of the banks before the 2008 crisis and after the 2008 crisis. Research results showed significant differences between the beta and the averages of all banks before and after September 15, 2008.
Keywords: Capital Asset Pricing Model, Risk, Beta

1. Introduction

The return and risk of a financial asset, and the relationship between the two have great implications for investors. In securities investments, investors give most importance to the relationship between risk and return. The return of a financial asset is the difference between the amount invested at the beginning and the value the asset at the end of the period. The risk can be expressed as the probability of deviation from the expected (Sahin, 2006, p.3). There are two types of risk; systematic and non-systematic risks. Systematic risks are purchasing power (inflation) risk, interest rate risk, market risk, political risk and exchange rate risk. Non-systematic risks are; financial risk, management risk, business and industry risk. Non-systematic risks are the company-specific and the industry, which the company operates, specific risks. Such risks can be diversified by including different securities in portfolio (Birliği, 2005, p.78) Systematic risks are risks that affect the prices of all traded securities at the same time and cannot be removed by diversification (Şahin, 2006, p.8)

Capital asset pricing model (CAPM) is a model which is used to calculate the expected returns of risky assets and is constructed by William F. Sharpe (1964), by developing Markowitz's portfolio theory with the contributions of John Lintner (1965) and J. Mossin (1966). Capital Assets Pricing Model (CAPM) explores whether an asset, that is planned to be invested by an investor, secure the return that is appropriate with the risk it carries and explains the return that assets that are not traded in the market should provide (Köroğlu, 2009, p.1). In the CAPM, the systematic risk

of any financial asset is measured by beta. The beta coefficient is a measure of the extent to which a financial asset moves or does not move with the markets (Köroğlu, 2009, p.79).

In the CAPM, the value of a financial asset depends on the relationship between the expected return and the risk, and this relationship is assumed to be linear (Kulalı, 2016, p.282)

The Capital Assets Pricing Model has a number of assumptions. These are (Birliği, 2005, pp. 80):

- Since there are many buyers and sellers in the market, the market price of securities is not affected by individual behavior.
- The investment period is the same for each investor and the securities are held during a single period.
- All assets can be divided and marketed.
- There are no taxes or transaction costs.
- All investors avoid risk and want to increase their returns at the end of the period.
- Investors have homogeneous expectations of return and variance. Because investors have the opportunity to access all information without any financial burden.

2. Literature Review

In the study on capital asset pricing model conducted by Ege et.al. (2011), the beta of 11 banks traded in the ISE between 2006 and 2010 was estimated and the expected return was calculated by using the Capital Assets Pricing Model. Regression analysis was used to measure the relationship between market risk and stock returns. As risk-free interest rates monthly percentage changes in interest rates on treasury bills were used; and the monthly percentage change of the ISE National 100 Index average was taken as the market portfolio. Research results concluded that the bank stocks with high beta coefficient have a high risk and return. Şekerbank, TEB (Turkish Economy Bank) and Garanti Bank have the highest betas while Deniz Bank and Finans Bank have the lowest betas.

Another study on capital assets pricing model was done by Sabuncu (2005). In this study, the monthly rate of return of the 91 stocks traded in the ISE in the period between April 1999-March 2004 and the ISE 100 Index market return rates were tested using Capital Asset Pricing Model. In this study, the beta coefficients were found by using time series regression in the first stage and cross-sectional regression was used in the second stage in order to measure how linearly the rate of return and the beta coefficient obtained by time series regression are related to each other. The results of the research concluded a linear positive correlation between the beta coefficients of the ISE stocks and the expected returns and the risk premium was found to be positive. In addition, it was concluded that the Capital Assets Pricing Model has been partially supported in the ISE.

Another study was conducted by Sumer and Hepsağ (2007). In this study, the validity of the Capital Assets Pricing Model was tested using 15 stocks traded in ISE National 30 Index between the years 2000 and 2007. The market risks of these stocks were estimated using the parametric

regression model. The research results indicated that the relationship between stock returns and market returns is not linear, as explained by the theory.

Another study on the Capital Assets Pricing Model was conducted by Yıldız (2009). This study consists of two parts. Firstly, the factors affecting the stock returns of the 82 companies registered to ISE National 100 Index for the period of 2003 and 2007 were tested using panel data analysis. Secondly, the applicability of the Capital Assets Pricing Model for the 1993 and 2007 period has been tested in the ISE. The research reached the conclusion that CAPM is valid in the ISE.

The two basic models used in financial assets pricing, Capital Assets Pricing Model and Arbitrage Pricing Model were examined by Altay (2001). CAPM was tested with a two-stage regression model using monthly and daily return ratios of the portfolios composed according to the greatness of the beta coefficients and of the equity profitability ratios. Arbitrage pricing theory was tested by Factor Analysis and Multivariate Regression Analysis. The research was conducted using stocks traded in the ISE between 1994 and 2000 and concluded that the CAPM is not valid in the ISE. The results of factor analysis show that Arbitrage Pricing model is not valid in ISE.

In order to test the validity CAPM in other markets besides the ISE, Akagün (2006) conducted two-stage regression analyzes using the monthly returns ratios of 96 stocks out of 100 most traded stocks in the New York Stock Exchange (NYSE) for the period 1989-2005. Results of the research showed a statistically significant but non-linear positive relationship between beta and return ratios of assets.

3. Material and Methods

In this study, the data set is formed from daily closing prices of banks operating in BIST (Borsa Istanbul) between 31.12.2004 and 31.12.2015. The number of observations is 2869. Beta and return ratios of 8 banks operating in BIST were found with this study. It is also tested whether there is a relationship between beta values of the pre-crisis and post-crisis of 2008 based on the 2008 crisis and how the 2008 crisis caused a change in beta and return rates. Stock returns calculated with $r=LN(P_t) - LN(P_{t-1})$ formula are used in the analysis. The T-test was used to determine whether there is a difference between the averages of the betas for the banks and F-test is used to determine whether there is a difference between the variance before and after the crisis.

To find daily betas with GARCH initially MGARCH (multivariate GARCH) model is established. Both the mean and the variance are modeled by the GARCH method. Optimal AR processes are estimated and included in the model to form the mean equation. Since the error terms of all of the models are not normally distributed, the Students' t distribution is used. With GARCH model formed the daily covariance of each bank with the market variance is calculated. The daily betas of the banks are calculated as follows: β = Cov./Market Variance.

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4. Research Findings

In the analysis, the returns of the stocks are used, and the returns are calculated using the formula $r=LN(P_t) - LN(P_{t-1})$. Descriptive statistics of banks and return series included in the analysis are shown in Table 1.

Table 1. Descriptive Statistics

Code	Bank	Mean	Stand. Dev.	Max.	Min.	Jarque-Bera	ARCH- F Stat.
XU100	BİST100 National Index	0.037	1.705	12.127	-11.064	1666.516*	37.625*
AKBNK	Akbank	0.033	2.566	18.953	-12.084	931.449*	21.370*
FINBN	Finansbank	0.084	2.783	22.706	-15.082	16703.27*	204.347*
GARAN	Garanti Bank	0.060	2.592	15.906	-14.152	642.094*	23.666*
ICBCT	ICBC Turkey Bank	0.071	3.114	22.196	-21.905	6711.988*	135.991*
ISCTR	İş Bank (C)	0.028	2.464	16.034	-11.241	620.833*	21.792*
SKBNK	Şekerbank	0.061	2.754	17.934	-22.716	5141.480*	179.094*
TSKB	T.S.K.B.	0.098	2.474	13.510	-16.438	1084.856*	76.931*
YKBNK	Yapı ve Kredi Bank.	0.030	2.466	12.205	-16.068	950.402*	45.071*

* Statistically significant at 1% level.

The averages in Table 1 represent average returns from 2004 to 2015. While the bank with the highest return is TSKB; the bank with the lowest return is İş Bank. Since the standard deviation represents volatility, the highest volatility belongs to the ICBCT. All series are not normally distributed (jarque-bera) and all series have ARCH effect.

The stability of the series, which is another precondition, was tested with the ADF and PP unit root test, and the results are given in Table 2. As can be seen in the table, all the series are stable at a 1% significance level.

Table 2. ADF and PP Unit Root Tests

	Fixed Model		Trend ve Fixed Model	
Series	ADF	PP	ADF	PP
XU100	-14.562*	-52.379*	-14.574*	-52.380*
AKBNK	-52.671*	-52.852*	-52.670*	-52.860*
FINBN	-24.525*	-50.954*	-24.550*	-50.965*
GARAN	-14.682*	-54.345*	-14.715*	-54.371*
ICBCT	-28.215*	-53.166*	-28.211*	-53.159*
ISCTR	-17.020*	-53.686*	-17.026*	-53.682*
SKBNK	-24.448*	-50.112*	-24.465*	-50.113*
TSKB	-35.842*	-51.314*	-35.868*	-51.326*
YKBNK	-52.198*	-52.181*	-52.205*	-52.188*

* stands for the stability at a 1% level of significance.

The graphics of price series are given in Figure 1. The vertical line on the graphs represents the September 15, 2008 financial crisis.

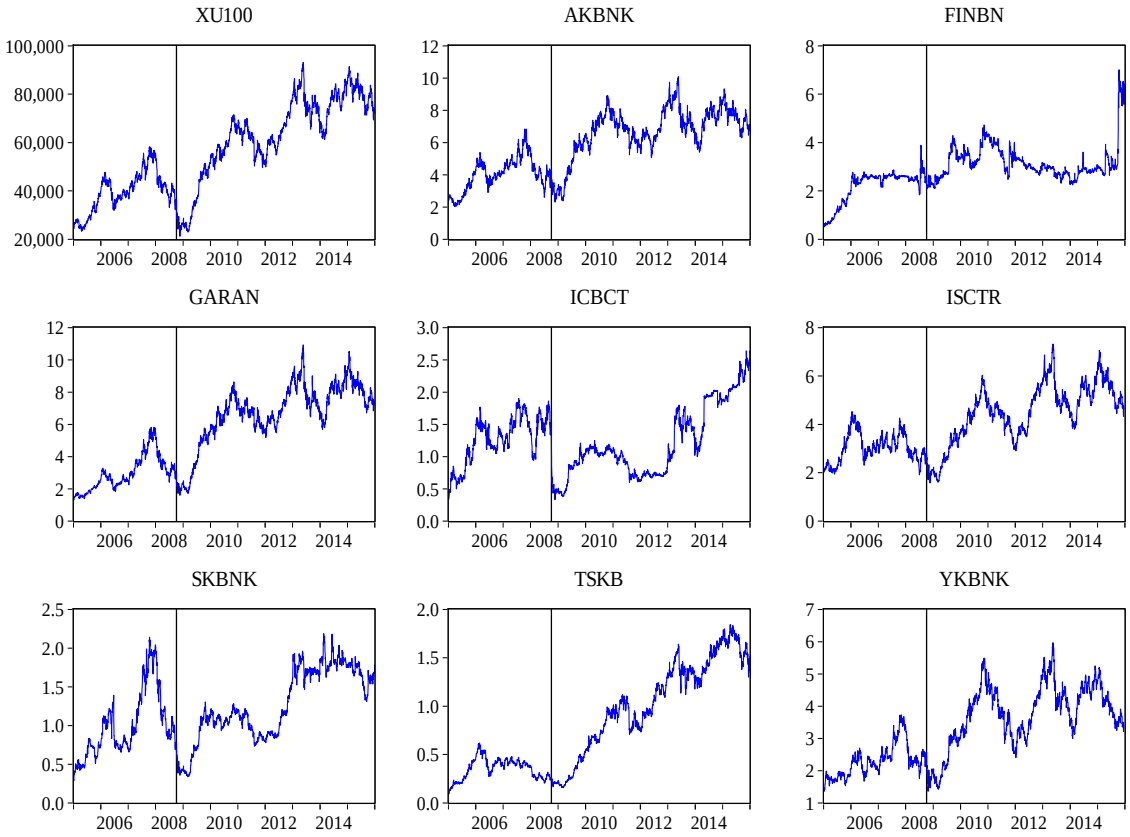

Figure 1. Graphical representation of price series

As can be seen in Figure 1, a series of changes occurred in given price series before and after 2008.

To find daily betas with GARCH initially MGARCH (multivariate GARCH) model is established. Both the mean and the variance will be modeled by the GARCH method. Optimal AR processes are estimated and included in the model to form the mean equation. Since the error terms of all of the models are not normally distributed, the Students' t distribution is used. With GARCH model formed the daily covariance of each bank with the market variance is calculated. The daily betas of the banks are calculated as follows: β = Cov./Market Variance.

The graphical representation of daily betas belonging to the banks is shown in Figure 2.

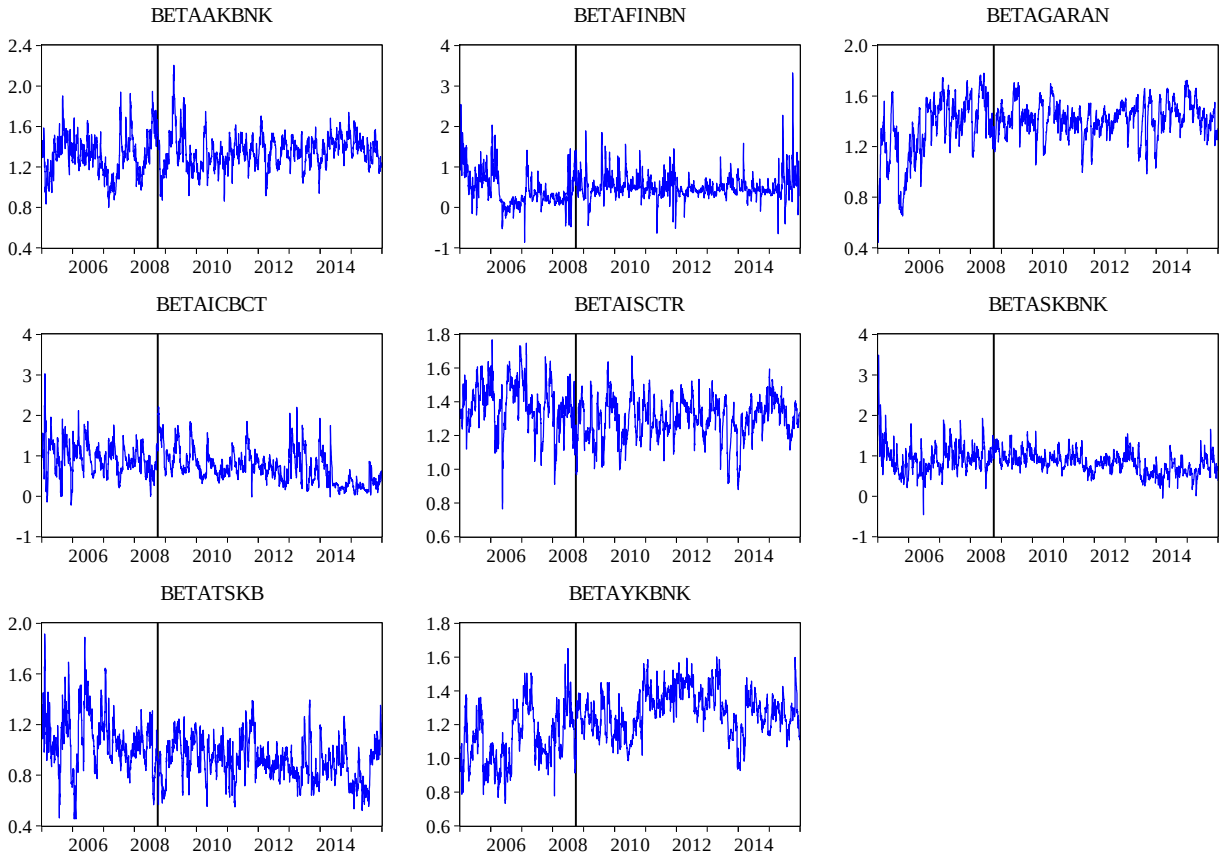

Figure 2. Graphical Representation of the Bank Betas

The descriptive statistics of the betas are given in Table 3. This table contains the mean of the beta, median, maximum, minimum value and standard deviation.

Table 3. Descriptive Statistics of Banks' Betas

	Mean	Median	Maximum	Minimum	Stan. Dev.
β_{AKBNK}	1.340	1.339	2.204	0.798	0.177
β_{FINBNK}	0.488	0.437	3.323	-0.865	0.350
β_{GARAN}	1.392	1.418	1.782	0.443	0.187
β_{ICBCT}	0.788	0.753	3.025	-0.220	0.425
β_{ISCTR}	1.326	1.335	1.768	0.765	0.136
β_{SKBNK}	0.861	0.845	3.489	-0.456	0.305
β_{TSKB}	0.969	0.951	1.915	0.453	0.197
β_{YKBNK}	1.225	1.243	1.651	0.732	0.161

When we look at Table 3, Garanti Bank has the highest beta average while the bank with the lowest beta average is Finansbank. The bank with the highest standard deviation is the ICBCT Bank and the bank with the lowest standard deviation is İş Bank.

The T-test was used to determine whether there is a difference between the averages of the betas for the banks and F-test is used to determine whether there is a difference between the variance before and after the crisis and the results are shown in Table 4. The results indicate that there is a significant difference between the pre and post-2008 beta averages of all banks. Significant differences were found before and after 2008 (September 15) between the variances of all banks except for ICBCT.

Table 4. Impact of the Crisis on Bank Betas

	Before the 2008 Crisis (N=966)		After the 2008 Crisis (N=1903)		Mean	Variance
	Mean	Stan. Dev.	Mean	Stan. Dev.	T-test Stat.	F-Test Stat.
β_{AKBNK}	1.313	0.203	1.353	0.161	-5.733*	1.594*
β_{FINBNK}	0.438	0.436	0.513	0.294	-5.4864*	2.198*
β_{GARAN}	1.330	0.256	1.424	0.128	-13.131*	3.964*
β_{ICBCT}	0.941	0.407	0.711	0.413	14.194*	1.032
β_{ISCTR}	1.384	0.146	1.297	0.120	16.913*	1.498*
β_{SKBNK}	0.935	0.383	0.823	0.248	9.475*	2.391*
β_{TSKB}	1.081	0.221	0.912	0.156	23.649*	2.004*
β_{YKBNK}	1.113	0.163	1.282	0.127	-30.686*	1.651*

* Statistically significant at the 1% level.

5. Conclusion

In this study, the t-test was conducted to test whether the averages of the betas differed significantly before and after the crisis, and the results show that the betas all differed. However, while average betas of some banks have increased, some others have decreased. The F-test was also conducted to test whether the variances of the betas were significantly different before and after the crisis. According to the F test results, except for the ICBCT bank, all other banks were found to be different. In conclusion, the 2008 crisis seemed to have a significant effect on the betas of the banks.

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