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Abstract

The CAPM suggests that stock returns are linearly dependent to the market returns. The only risk factor that an asset bears is the market risk which is captured by the asset's beta. But the CAPM equation does not say much about the causal relationship between market and asset returns. In order to test the validity of the CAPM equation, we have applied Granger causality tests. The causal relationship between the Istanbul Stock Exchange 100 index and banking sector stocks are examined through Granger tests. The data between 04.12.2007 and 04.12.2009 are used for the analysis. Overall we have found weak causal relationships between market and asset returns, therefore the CAPM is not an adequate model for the asset returns of Turkish banking stocks.

Keywords: CAPM, Granger causality, unit-root tests

1 Introduction

Although there exist several theoretical and empirical critics, the capital asset pricing model (CAPM) has been and is still one of the mostly used standard methods for financial researchers and agents to quantify the relationship between risk and return in the financial markets. The CAPM which was developed by Sharpe (1964), Lintner (1965), and Mossin (1966) suggests that it is not possible to consistently outperform the market as all the information is already reflected to the prices, therefore high expected returns are associated with high levels of risk. Simply, the CAPM states that the expected return on an asset above the risk-free rate is linearly related to the non-diversifiable risk as measured by the asset's beta. This is captured by the regression of asset returns on market returns.

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$r_t = \alpha + \beta r_{Mt} + u_t$ (1)

The regression coefficient beta represents the sensitivity of returns of the security to changes in market returns. However, the developments in econometric theory undermine the simplicity of this approach. As Dash et.al (2008) point out that two concepts become relevant in this concept. First of all, there should be some sort of causality from market returns to asset returns. Although regression analysis of the CAPM deals with the dependence of asset returns on the market returns, it does not necessarily imply causation. In other words, the existence of a relationship between asset and market returns does not prove causality or the direction of influence. But in regressions involving time series data, the situation may be somewhat different because, time does not run backward. That is, if event A happens before event B, then it is possible that A is causing B. However, it is not possible that B is causing A. In other words, events in the past can cause events to happen today. Future events cannot. This is roughly the idea behind the Granger causality test. Secondly, in order to have robust results from the regression the time series of the asset returns and the market returns should be stationary, the presence of a unit-root will yield spurious results and biased beta coefficient estimates.

A recent study on the subject was proposed by Dash et.al in 2008. They investigated the Granger Causality between the stocks and index (NIFTY) returns of the National Stock Exchange (NSE), India. They randomly selected 30 stocks from the index and used the first difference of daily returns between the period of January 1, 2003 and December 31, 2007. They empirically found out that there is a strong causality relationship between sample stocks and the NIFTY index for the sample period. There are significant bi-directional causality between 93.33% of the sample stocks and NIFTY index. They also confirmed that all the sample stocks and index returns are stationary.

In this paper, we move on to this area by appling the Granger causality analysis in the banking sector of the Istanbul Stock Exchange. The rest of this paper as follows, data and methodology are presented in section 2. Empirical results are interpreted in section 3. And section 4 concludes.

2 Methodology

We investigated Granger causality between banking sector stocks and the stock market index IMKB100 in the Istanbul Stock Exchange for this paper. The data for the analysis are the daily log returns of the 10 banks listed on the stock exchange and the IMKB100 between the two year period of December 04, 2007 and December 04, 2009. The data was retrieved from Thomson One Banker and IMKB web site.

In order to investigate the causality between the daily returns of stocks and the daily returns of the IMKB100, the linear Granger causality tests were applied. We have applied the following methodology for Granger causality test which involves the estimation of following models. For testing the causality of daily returns of IMKB100 on daily returns of the stocks, compare the unrestricted model:

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{m1} \beta_{1i}\Delta y_{t-i} + \sum_{j=1}^{m2} \theta_{1j}\Delta x_{t-j} + e_{1t} \quad (2)$$

with the restricted model

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{m1} \beta_{1i}\Delta y_{t-i} + e_{1t} \quad (3)$$

For testing the causality of daily returns of the stocks on daily returns of IMKB100, compare the unrestricted model:

$$\Delta x_t = \alpha_2 + \sum_{i=1}^{m1} \beta_{2i}\Delta x_{t-i} + \sum_{j=1}^{m2} \theta_{2j}\Delta y_{t-j} + e_{2t} \quad (4)$$

with the restricted model

$$\Delta x_t = \alpha_2 + \sum_{i=1}^{m1} \beta_{2i}\Delta x_{t-i} + e_{2t} \quad (5)$$

where Δx_t is the first order forward difference in the daily returns of IMKB100 and $\Delta y_t$is the first order forward difference in the daily returns of the stocks. α, β, θ are the parameters to be estimated and $e_{1,}e_2$ are standard random errors. The lag orders m are the optimal lag orders chosen by Schwarz Information Criterion (SIC). We have decided to use SIC instead of Akaike's (AIC) in the paper in terms of model parsimony, because the main disadvantage of the AIC is that it provides overparametrized models comparing to SIC.

The equations we have described above are convenient tools for analyzing linear causality relationships. If θ_1 is statistically significant and θ_2 is not , the it implies that changes in daily returns of IMKB100 granger cause changes in daily returns of the stocks the stocks with no feedback. Which means there is one way Causality relationship between IMKB100 and selected stock, where past values of daily returns of IMKB100 improves the predictions of changes in daily returns of the stocks, while knowledge of the past values of the changes in the daily returns of stocks has no influence over the IMKB100 returns. If θ_2 is statistically significant whereas θ_1 is not. We can infer that daily returns of stocks does Granger cause IMKB100, and past values IMKB100 does not have any influence over stock returns. If both of them are statistically significant, there are bi-directional causality between IMKB100 returns and stock returns. If both of them are statistically insignificant, we can say that neither past values of IMKB100 returns nor the past values of stock returns have any effect on the other series.

In order to have robust regression results, the series which used in the analysis must be stationary. The augmented Dickey-Fuller unit root test is the most popular method to test the presence of a unit root in the series. The model for the ADF test can be represented as:

$$\Delta z_t = \alpha + \beta_t + \gamma z_{t-1} + \sum_{i=1}^{m} \delta_i \Delta z_{t-i} + e_t \quad (6)$$

Where Δz_t is the first order forward difference in the time series, z_{t-1} is the one-period lag in the time series, and Δz_{t-i} are lagged values of Δz. The coefficient α is the drift parameter, β is the trend parameter, and γ represents the unit root. Finally, the m represents the optimal lag order for the test chosen by Schwarz information criterion (SIC).

3 Empirical Results

3.1 Granger Causality Tests

The Granger causality test were performed to test the direction of causality between the daily returns of 10 stocks of the banking sector and the daily returns of IMKB100. In performing tests, the lag structure is chosen according to Schwarz information criterion (SIC). The reason we have decided to use different lag order for each series is that using same lag for every series could yield spurious results. As Lutkepohl (1993) points out that using lower lag order than the true one will cause autocorrelation errors and higher lag order than the true one will cause biased coefficient estimates. The tables 1 and 2 below show the results of the Granger causality tests.

Table 1 : Results of Granger Causality Tests of IMKB100 on Stocks

	Lag Order	R^2	F-Value	p-value
Akbank	9	46.33%	2.68845	0.00469*
Finansbank	10	41.92%	1.66414	0.08643
Fortis	8	46.88%	2.66805	0.00713*
Garanti	9	48.29%	1.40125	0.18470
Halkbank	9	45.43%	2.02998	0.03453*
İs Bankasi	4	37.51%	1.99854	0.09361
Sekerbank	4	37.70%	0.35004	0.84402
TEB	9	50.69%	1.71234	0.08364
Vakifbank	4	34.05%	1.91966	0.10594
YKB	4	36.05%	2.44103	0.04065*

Table 2: : Results of Granger Causality Tests of Stocks on IMKB100

	Lag Order	R^2	F-Value	p-value
Akbank	9	44.59%	1.89782	0.05029
Finansbank	10	44.92%	1.30055	0.22784
Fortis	8	42.23%	1.79692	0.07547
Garanti	9	43.85%	1.8831	0.30023
Halkbank	9	43.95%	1.28174	0.24419
İs Bankasi	4	35.34%	0.42048	0.79394
Sekerbank	4	36.14%	1.94126	0.10242
TEB	9	45.01%	2.31528	0.01486*
Vakifbank	4	30.45%	0.62646	0.64383
YKB	4	36.67%	2.96250	0.01947*

The results from the Granger causality tests indicate that there is only one of the stocks (YKB) has bi-directional causality with the IMKB index. Table 1 shows that the changes in the daily returns of IMKB100 index Granger cause 40% of the stocks in the banking sector, whereas 60% of the banking stocks returns do not have affected by the IMKB100 past returns. And according to results from table 2 only 20% of the stocks in banking sector does Granger cause IMKB100 returns. We can infer from the results that for the sample period there are weak causal relationships between the banking sector stocks and the IMKB100 index returns.

3.2 Unit-Root Tests

The augmented Dickey-Fuller unit root tests were employed in order to determine the stationarty structure of the series. The table 3 below shows the results from the ADF unit-root tests.

Table 3: ADF Unit-Root Tests Results

	α	p-value	β	p-value	γ	p-value
Akbank	-0.004038	0.2108	0.00000473	0.1367	-0.934638	0
Finansbank	-0.000803	0.7939	0.0000265	0.6595	-0.883597	0
Fortis	-0.006766	0.0319	0.0000202	0.016	-0.973344	0
Garanti	-0.06034	0.0684	0.0000155	0.0364	-0.961607	0
Halkbank	-0.005031	0.1358	0.0000234	0.086	-0.912382	0
İs Bankasi	-0.004108	0.1631	-0.0000334	0.1323	-0.929865	0
Sekerbank	-0.006694	0.0362	0.0000245	0.0357	-0.864009	0
TEB	-0.008658	0.0089	0.000017	0.0039	-0.974761	0
Vakifbank	-0.006023	0.0525	0.0000156	0.0239	-0.85533	0
YKB	-0.004565	0.1361	0.0000242	0.111	-0.918077	0
IMKB100	-0.004001	0.0607	0.0000188	0.0367	-0.908682	0

The results of the augmented Dickey-Fuller tests indicate that, for all the daily returns of stocks and the daily returns of IMKB100 the unit root hypothesis is rejected at all significance levels. The coefficient γ (unit root coefficient) is significantly less than 0 for every series, which means series do not have unit root and they all are stationary. Although some stocks have statistically meaningful drift and trend components, they are not significant in terms of coefficient value. By rejecting the null hypothesis of unit root for all of the series, we can therefore say that the causality relations identified in the previous section are robust and reliable.

4 Conclusion

This paper is an analysis of Granger causality in the CAPM testing. We have used daily log returns of 10 banking stocks and log returns of IMKB100 index for two year period between December 4, 2007 and December 4, 2009 in order to examine the Granger causality between index and stock returns. The findings of our study indicate that IMKB100 returns does Granger cause 4 stocks out of 10, and 2 out of 10 stocks does Granger cause IMKB100 returns, and only one stock has bivariate causality relationship with the market. The empirical findings of our report suggest that, for the sample period the security line as represented by the regression in equation (1) is inadequate for the stocks that have no causality relation with the market. Therefore, we can not use only market factor in order to explain the stock returns. In this case we should result to multifactor statistical models such as Fama-French three factor model or Carhart four factor model. By including additional explanatory variables, the unexplained part of stock returns in CAPM can be captured by other risk factors.

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