

**THE INTERACTION BETWEEN BIST100, DOW JONES AND MSCI
BEFORE AND AFTER LEHMAN BROTHERS' COLLAPSE;
EVIDENCE FROM TIME SERIES DATA BY VAR**

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Abstract

According to the paper Lehman Brothers's collapse is a turning point for global markets. Before Lehman's collapse we can say that Turkey can be considered as a emerging market but below the average among them since Turkey had more fragile economics than most of the other emerging markets. one should expect that the BIST100 movements could only be explained by only its lag values and Dow Jones Return but not MSCI Index movements however after the Lehman's collapse period, we see that Turkey's economic condition has been improved continuously so one can suspect that that that MSCI would be an explanatory variable for the BIST100 movement in addition to BIST100's own lags and Dow Jones's lag values because MSCI should react quicker to global shocks because after Lehman's collapse Turkey's economic condition can be considered better than the average Emerging market countries. So the main objective of the paper is to find out how BIST100 movements can be explained by its own , Dow Jones and MSCI lags before and after the collapse of Lehman Brothers. The paper also studies effects of positive and negative closing prices' on the following day's closing prices of indexes. The last hypothesis studied in this paper claims that after Lehman's collapse, the effectiveness of emerging markets' on world's economy has increased meaning that while pre-Lehman's collapse Dow Jones movements is explained by only its lag values, after Lehman's collapse, emerging markets has increased their effectiveness in the global economy and has started to affect the movements of Dow Jones in addition to Dow Jones effect over itself. The paper uses time series daily data containing 2006-2008 for pre-Lehman's collapse period and daily data between 2008-2013 for the period after Lehman's collapse using VAR and MGARCH methodology. Our results suggest that after Lehman's collapse, Dow Jones Index is not the only global barometer for global financial markets anymore that is emerging markes are coming to the scene. In addition to global outcome of our hypothesis our results also support that after Lehman's collapse, Turkey has integrated to emerging markets more powerfully.

Keywords: Lehman Brother's Collapse, VAR modelling, Impulse response, variance decomposition, turning point

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INTRODUCTION

Global economics faced with one of the most destructive crisis at the last quarter of 2008 beginning with Lehman Brother's collapse. Many researches and paper were written about the reasons that caused such a huge global economic crisis. However our paper does not concentrate on the reasons that might cause such a crisis, in fact we have concentrated on the results of the crisis over financial markets and tried to find out what kind of differences have started to exist in financial markets when we compare with its pre-crisis state. Despite of the fact that many analysts suggested that the crises started at 2007, Lehman Brothers' collapse was a turning point and after Lehman's default, financial markets has realized that this huge crisis was not like the ones that happened before and then this huge crisis became a phenomenon in which all markets had to face with.

The effects of global economic crisis are minimized by bail-out plans and quantitative easing programme of FED and ECB. After implementing these bail – out plans USA economics has reached its pre-crisis position however FED continued its QE implementation. But as expected, after deep crises, there occurs many changes in the global markets. For instance, after 2008 crisis emerging markets effectiveness on global economic system have increased because of the fact that under heavy debt burden developed economies growth rates have declined significantly and austerity measures has slowed down the economic recovery. In fact when the amount of debt of developed countries is considered, it can easily be understood that their natural economic growth rates won't be reached even after long years. Thus emerging markets growth figures have overperformed and will go on to outperform the developed countries. So, in our opinion, effects of this rebalancing should be seen over financial markets. In other words, Dow Jones should be more sensitive China's inflation data from this turning point on.

Due to global financial crisis, Turkey's economy has shrunked at a rate of %9,2 approximately. After the effects of global crisis started to diminish, Turkey's economic conditions has begun to recover quickly and have started to fully integrate to emerging markets. As a result of this integration during the first half of 2013 Fitch and Moody's have hiked up Turkey's rate of foreign currency denominated debt to investment grade. Quick economic recovery, fully integration to emerging markets, sustainable economic growth and less political risks should have a positive effect over Turkey's financial markets. One may expect that since Turkey can be considered as one of the strongest links in emerging market leagues, BIST100 movements should be less sensible to global economic variations with respect to the average level of emerging markets in other words MSCI Index movements should react quicker to global economical variations especially to negative ones.

In other words before crisis MSCI Index would follow BIST100 however after the crisis one should expect BIST100 follow MSCI index which is a sign of more stable economic environment.

Also, some researcher point that when bad news prevail good news, the market indexes increases. So, our paper has tested this deriving by daily return data. Our last hypothesis is that if the market closes positively on a day, a negative close should be expected on the following day.

For our analyse daily time series data between the dates 2006-2013 has been used and divided into two parts. For the first part, namely pre-Lehman period, the data contains the daily returns between 2006-2008. Last quarter of 2008 is accepted as turning point which is the default of Lehman Brothers, and the second part of data starts with the collapse of Lehman Brothers and end in the May 2013. The paper uses vector autoregressive methodology to model data because of the fact that all these variables can be considered to be endogeneous that is related o each other , in fact from the results this presumption is confirmed.

The paper is organized as following:

- Section 2: Brief discussion of the data and the methodology
- Section 3 : Lag order Selections for VAR regression analysis.
- Section 4 : Estimation results
- Section 5 : Volatility Modelling of the variables
- Section 6 : Conclusions

SECTION 2:

METHODOLOGY & DATA

In the paper VAR methodology is employed to determine the relationship between the variables BIST100, MSCI and Dow Jones Index. A reduced form VAR is employed and therefore each equation can effectively be estimated using OLS. For a VAR to be unrestricted, it is required that the same number of lags of all of the variables is used in all equations. Therefore, in order to determine the appropriate lag lengths, in the first part of the VAR regression the multivariate generalisation of Akaike' s information criterion (AIC) and in the second part of the VAR regression Hannan-Quinn and Schwarz information criterion is used.

Within the framework of the VAR system of equations, the significance of all the lags of each of the individual variables is examined jointly with an F-test. Since several lags of the variables are included in each of the equations of the system, the coefficients on individual lags may not appear significant for all lags, and may have signs and degrees of significance that vary with the lag length. However, F-tests will be able to establish whether all of the lags of a particular variable are jointly significant.

Data , that has been analysed in the first part,were collected from the dates beginning from 04.01.2006 to 29.08.2008. We have chosen the last date for the first period as 29.08.2008. Lehman Brothers has collapsed by September 2008 which was the turning and most severe point of 2008 Global crisis and in our opinion, collapse of Lehman Brothers has changed the behaviour of the markets. Permanently. While filtering the sample period we eliminated the days if at least one of the three indexes is not traded for that day. So, our data consists of the dates in which all of the three indexes were traded. All data derived from the data providers namely Reuters, Bloomberg and Forex.

Total number of data that is used for the first part of analyses is 541 and this is enough for VAR modelling. In the analyse returns of the indexes has been used instead of indexes themselves. This is because, in order to apply VAR modelling, the data has to be mean reverting and constant variance that means data has to be stationary and also otherwise accuracy of F-test which is necessary for Granger causality test will be biased and therefore questionable.

In the second part, that is the period collapse of Lehman Brothers', data has been collected beginning from the date 30.08.2008 till the date 17.05.2013. Total number of data that were used is 922 which is enough for VAR modelling.

SECTION 3:

LAG ORDER SELECTION CRITERIA PRE-AFTER LEHMAN COLLAPSE

First thing that is needed to do is to determine the appropriate lag order for VAR analyse of the variables Bist100, MSCI Index and Dow Jones for the period of pre and after period of Lehman Brothers' collapse. In order to determine the appropriate lag length lag order selection criteria is applied to the data. Output of the application indicates that for pre-Lehman period minimum AIC has been reached at the third lag. Except AIC, there exists other measures for determining the appropriate lag order namely the Schwarz and Hannan-Quinn information criterion and these criteria inform us that best lag order is two which is different from Akaike Information Criterion's lag order. However we know that none of these criteria has superiority on each other so 3 lag order is preferred for pre-Lehman period. As a result for pre-Lehman period according to Lag order selection criterion it can be said that tomorrow's data will be affected by the information of at most three days old. Thus we can say that according to lag order selection criterion data has short memory as expected.

According to Lag Order Selection Criterion for pre-Lehman period appropriate lag for VAR model is three with respect to Akaike information criterion, however after the collapse of Lehman Brothers appropriate lag is 19 but allowing 19 lags into the regression model will be impractical and will contradict with the desired property of parsimonious and since there does not exist any superiority between the information criteria of Hannan-Quinn, Schwarz and Akaike, we have decided to use two lags for VAR modelling which is suitable for Hannan-Quinn and Schwarz information criterion. Decrease in the lag number in VAR regression model with respect to pre-Lehman period can be considered as sign for evolving to an efficient market of BIST100 after the collapse of Lehman Brothers because in our opinion a model in which it incorporates all information in shorter memory, is more efficient and more close to random walk.

SECTION 4:

ESTIMATION & RESULTS

A. VAR Methodology

Table1. Before Lehman's Collapse Interconnectedness between BIST100, Dow Jones and MSCI

	BIST100 Return	MReturn	DReturn
BIST100Return(-1)	-0,13 * [-2.70954]	0,29 *** [-11,0961]	0,00 [0,03848]
BIST100Return(-2)	-0,05 [-0.96513]	0,06 * [1,96344]	-0,02 [-0,79662]
BIST100Return(-3)	-0,07 [-1.29576]	-0,01 [-0,26103]	0,01 [0,29705]
MReturn(-1)	0,11 [1.52885]	-0,11 * [-2,52000]	0,04 [1,01861]
MReturn(-2)	0,10 [1.26665]	-0,06 [-1,31299]	-0,06 [-1,47252]
MReturn(-3)	0,03 [0.56535]	0,07 * [2,15482]	-0,03 [-0,82284]
DReturn(-1)	0.73 *** [8.11857]	0,52 *** [10,3725]	-0,13 [-2,81755]
DReturn(-2)	0.22 * [2.14693]	0,42 *** [7,17542]	-0,08 [-1,47221]
DReturn(-3)	0.05 [0.51173]	0,22 ** [3,65117]	0,09 [1,67967]
R-squared	0.118828	0,472777	0.037359
Adj. R-squared	0.103577	0,463652	0.020698
F-Statistic	7.791487	51,81112	2.242297

I. VAR Results for pre-Lehman period

When we consider the regression equation in which BIST 100 is dependent variable while MSCI and Dow Jones are independent, It can be seen that BIST 100's daily return is only affected by the first lag of itself and the first two lags of Dow Jones index at the 95% confidence interval level. That means between 2006 and the collapse of Lehman Brothers, MSCI does not have any explanatory power over BIST 100 index. In fact Granger Causality tests verify this conclusion that is Dow Jones index Granger cause but MSCI does not Granger cause to BIST100 index. An interesting point to note is that the coefficient of first lag of BIST100 is negative and statistically significant meaning that if we consider only the effect of BIST100 and neglect other factors when BIST100 closes the day positive, one should expect that BIST100 will close negative in the other day. Similarly when

we only consider the effect of Dow Jones that is when we neglect the effect of BIST100 over itself, Dow has positive effect on BIST100 that is while Dow increases one should expect also an increase in BIST100 the following day. Same situation is also valid for MSCI and DOW that means if one index increases in a day then the other other day index most probably will decrease *ceteris paribus*. The reason for this fact is maybe that since we are dealing with daily returns which means high frequency, short period data, an increase most probably be considered as an opportunity to realize profit and any decrease will be considered as potential for entering the market for short term investors in other words traders. In fact some of researchers has investigated that the market has a tendency to increase after the week of bad news release. The reason for this phenomenon may be related with this case.

Another important point is that while only first lag of BIST100 has an explanatory power on itself, first two lags of Dow Jones has been affecting the behaviour of BIST 100 at %95 confidence level that is it seems Dow Jones was more effective over BIST100 in terms of memory with respect to BIST100 index itself. As a result it can be concluded that before the collapse of Lehman Brothers MSCI does not affect BIST100 movements because emerging market indexes is generally much more affected by global events rather than their local news flow during high volatile times and since Turkey's economical condition is much more fragile mostly because of political instability and high current account deficit risk, BIST 100 reacts to global news more quickly than the emerging markets in this period. This may indicate that Turkey was the weakest link of emerging market chain during the first period. Another conclusion derived is that in Turkey, proportion of short run foreign investments namely portfolio investments before the collapse of Lehman Brothers were higher with respect to other emerging markets. This can be considered as a sign and cause of unstable economic conditions and high volatile market. Another derived result is that Turkey should not be considered as an emerging market according to precrisis period data. We recommend that other researchers should investigate this conclusion.

When we consider the equation in which Dow Jones index is dependent variable, it is seen that only first lag of Dow jones affect itself and this conclusion is verified by Granger Causality test as we will see in the following part of the paper. As a result since just one lag of Dow affects itself, it can be concluded that DOW can be modelled by AR(1) that means Dow behaves in a much more random walk way manner than MSCI and BIST100. This means that most of the past information has been reflected in prices so that it is enough to use first lag to make the best prediction for the future movement of Dow and also one can conclude that Dow market is more efficient than MSCI and BIST 100 because of its almost random walk property.

According to VAR 3 equation results in the pre-crisis period MSCI has been affected by first and third lag of itself, first lag of BIST100 and all of the three lags of Dow Jones index. We could not find any logical explanation why second lag of MSCI does not affect itself. However according to these results one conclude that MSCI has longer memory than Dow Jones and BIST100 index this may be sign for inefficiency in the market so we can say that MSCI's behaviour resembles in a less likely way to random walk with respect to Dow.

II. VAR Results for after Lehman period

Table2. After Lehman's Collapse Interconnectedness between BIST100, Dow Jones and MSCI

	BIST100 Return	MReturn	DReturn
BIST100Return(-1)	-0,04 [-1.02386]	0,23 *** [7.05404]	0,01 [-0.46441]
BIST100Return(-2)	0,06 [1.43198]	0,12 ** [3.51165]	0,01 [0.25638]
MReturn(-1)	0,14 * [3.53538]	-0,13 ** [-3.95217]	0,08 [2.63820]
MReturn(-2)	-0,05 [-1.58406]	-0,07 * [-2.63264]	0,00 [0.17088]
DReturn(-1)	0,27 *** [5.64658]	0,56 *** [14.0818]	-0,08 [-1.93965]
DReturn(-2)	-0,21 ** [-3.95787]	0,23 *** [5.27474]	-0,08 [-1.83265]
R-squared	0.072667	0,472777	0,01354
Adj. R-squared	0.066586	0,463652	0,00708
F-Statistic	11,95	51,81112	2.093827

When we consider the regression equation in which BIST 100 is dependent variable, the most important change in the model is that BIST100 own lags does not affect itself anymore and MSCI is an explanatory variable for BIST100 return. What is the possible meaning of this change? In our opinion, this change can be considered as a sign that Turkey is not the weakest link of emerging market league anymore in fact it is maybe one of the strongest members in emerging markets. Most probable reasons for this change are that Turkey's economic conditions became more flexible and more resistive to global shocks, strong recovery performance after crisis, diminishing political risks and tensions and resistive economic conditions, improving financial sources of current account deficit and increasing export volumes to regions other than Europe. As a result of these improvements proportion of long run foreign investments in Turkey after the collapse of Lehman Brothers increased with respect to other emerging markets. This can be considered as a sign of more

stable economic conditions and lower volatile market. In fact recently Fitch and Moody's have hiked Turkey's ratings to investment grade and so these rate hikes confirm our derivings.

Another change in VAR regression results is that MSCI becomes an explanatory index for both of Dow Jones and BIST100 after Lehman collapse period while this situation was not valid for pre-Lehman period. In our opinion reason for this change is that emerging markets has becomen more important for investors in other words Dow Jones Index is not only financial barometer for global markets after collapse of Lehman.

One can see from Granger Causality test results, MSCI does granger cause to BIST100 and Dow , Dow granger cause BIST100 and MSCI and lastly BIST100 only granger cause to MSCI. All of these results are in line with VAR 2 regression results.

B. Granger Causality Test

I. Pre-Lehman Period Granger Causality Test Results

Table 3 Pre-Lehman Granger Causality Test Results

Dependent variable: BIST100RETURN

Excluded	Chi-sq	df	Prob.
MRETURN	4.116925	3	0.2491
DRETURN	66.76458	3	0.0000
All	69.38326	6	0.0000

Dependent variable: MRETURN

Excluded	Chi-sq	df	Prob.
BIST100RETURN	123.8153	3	0.0000
DRETURN	139.3304	3	0.0000
All	450.0165	6	0.0000

Dependent variable: DRETURN

Excluded	Chi-sq	df	Prob.
BIST100RETURN	0.864833	3	0.8339
MRETURN	4.383494	3	0.2229
All	5.293572	6	0.5067

According to test results, only Dow Jones granger cause to BIST 100. BIST 100 and Dow Jones granger cause to MSCI and none of MSCI and BIST 100 granger cause to Dow Jones. Granger Causality test results are in line with VAR 3 results.

It is important to note that the term ‘Granger causality’ is something of a misnomer since a finding of ‘causality’ does not mean that movements in one variable physically cause movements in another. For example, in the above analysis, if movements in the BIST100 were found to Granger-cause movements in the MSCI market, this would not have meant that the MSCI market changed as a direct result of, or because of, movements in BIST100 market. Rather, causality simply implies a chronological ordering of movements in the series. It could validly be stated that movements in the BIST100 appear to lead those of the MSCI market, and so on. In other words Information is incorporated slightly more quickly in BIST100 and after MSCI.

II. After Lehman Period Granger Causality Test Results

Table 4 After Lehman Granger Causality Test Results

Dependent variable: BIST100RETURN

Excluded	Chi-sq	df	Prob.
MRETURN	15.19671	2	0.0005
DRETURN	59.18789	2	0.0000
All	66.64666	4	0.0000

Dependent variable: MRETURN

Excluded	Chi-sq	df	Prob.
BIST100RETURN	57.87621	2	0.0000
DRETURN	204.2593	2	0.0000
All	493.4283	4	0.0000

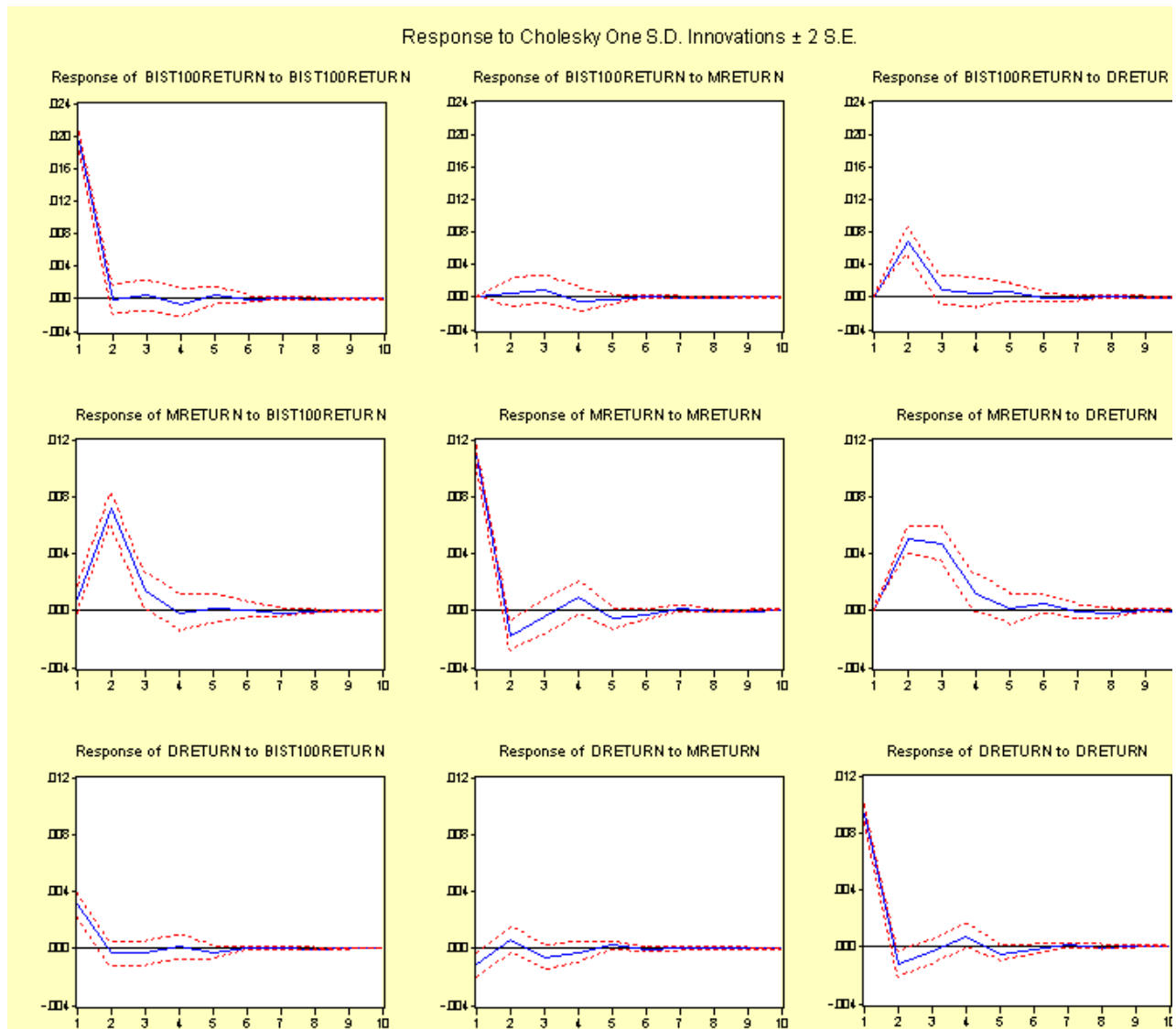
Dependent variable: DRETURN

Excluded	Chi-sq	df	Prob.
BIST100RETURN	0.307037	2	0.8577
MRETURN	6.976356	2	0.0306
All	8.145452	4	0.0864

After Lehman Brother's collapse most important changes are that MSCI granger causes to BIST100 and MSCI granger causes to Dow Jones. The reason for these changes respectively may be that as we mentioned above effectiveness of emerging markets in global has increased and Turkey became a much more stable , high growth economy after Lehman's collapse.

C. Impulse Responses

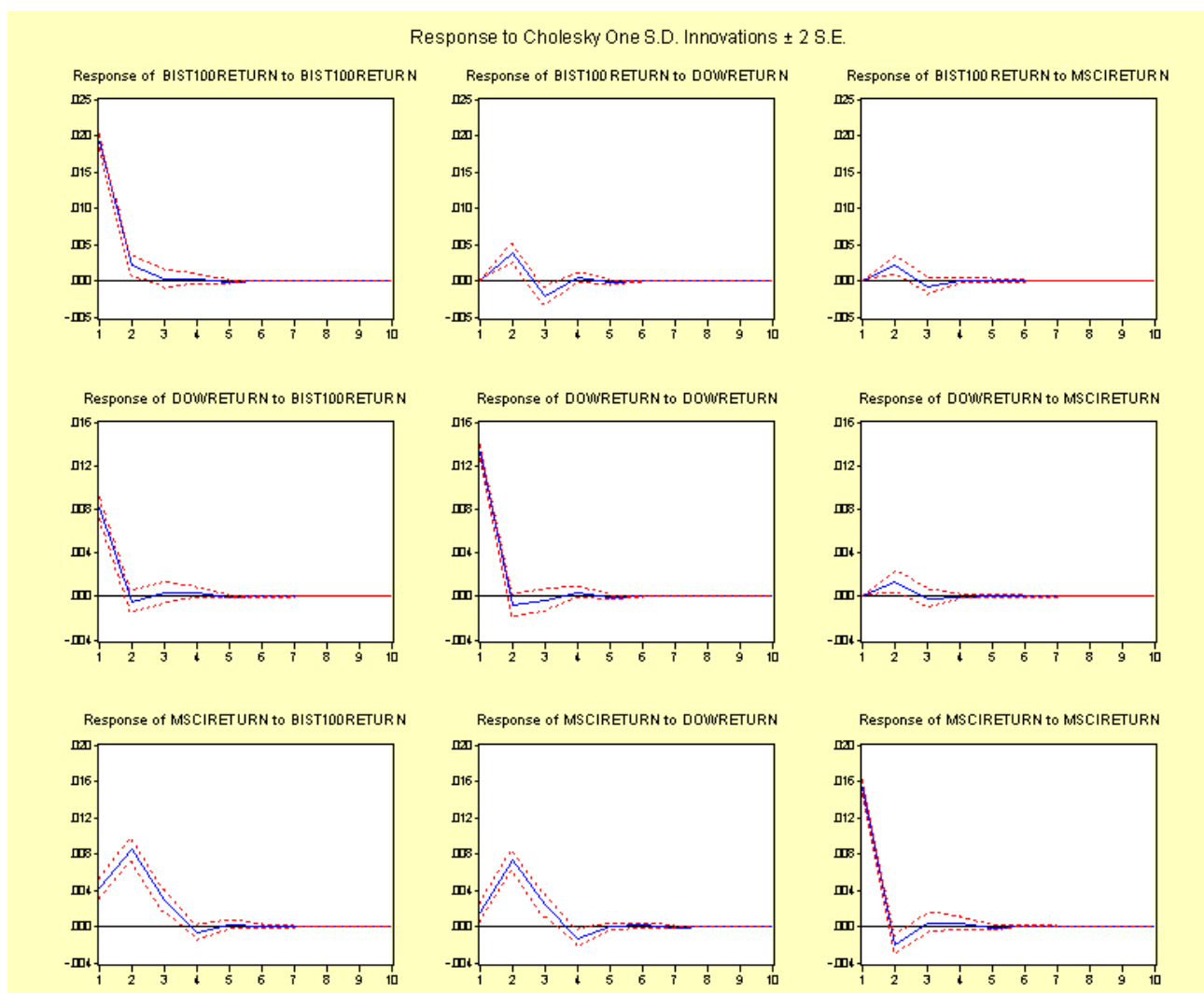
I. Pre-Lehman Period Impulse Responses



For period between 2006 and the collapse of Lehman Brothers' responses of the variables to the shocks except their own shocks are very limited and they fade away after the first lag, this may imply that model is stationary. When we look at the impulse response graphs of the BIST100, MSCI and Dow Jones, we see that any shocks occurred in BIST100 response of itself can be seen intensive

in one step ahead of shock occurrence and after then shock effects fade out may imply that model is stationary. Similarly if any shock happens to Dow Jones, its effect on BIST100 can be recognized in two step ahead. If any shock happens to MSCI, response of BIST100 to this shock is negligible. In fact all of these results are in line with the statistical significance of VAR regression results in which BIST100 is dependent variable. An interesting point to mention is that any shock on BIST100 has an effect on Dow Jones in the following day, even though BIST100 does not granger cause to Dow Jones.

II. After Lehman Period Impulse Responses



Similar results have been obtained for the impulse response functions of the period after Lehman Brothers' collapse. Similar with pre-Lehman period responses are very limited except for the response of a variable to its own shock and they die down almost nothing after the first lag. At the impulse response graphs of the BIST100, MSCI and Dow Jones, one can see that any shocks occurred in BIST100, response of BIST100 can be seen intensively in one step ahead of shock

occurrence and after then shock effects die away meaning that model is stationary but contradicts with VAR2 regression results because coefficients of BIST100 are insignificant . Similarly if any shock happens to Dow Jones , its effect on BIST100 can be recognized in three step ahead. If any shock happens to MSCI, response of BIST100 to this shock is not negligible anymore and suitable with VAR 2 regression results. Again with VAR3 impulse response functions an interesting point to mention is that any shock on BIST100 has an effect on Dow Jones in one step ahead even though BIST100 does not granger cause to Dow Jones. Any shock on BIST100 has an effect on MSCI in four step ahead which is appropriate with the fact that BIST100 does granger cause to MSCI.

D. Variance Decomposition Results

I. Pre-Lehman's Collapse Period

Table 5 Pre-Lehman Variance Decomposition Simulations

Variance Decomposition of BIST100RETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.019418	100.0000	0.000000	0.000000
2	0.020617	88.70934	0.387171	10.90349
3	0.020662	88.35441	0.648110	10.99748
4	0.020684	88.26705	0.677505	11.05545
5	0.020700	88.17578	0.692391	11.13183
6	0.020701	88.17409	0.693297	11.13262
7	0.020702	88.16641	0.695254	11.13833
8	0.020702	88.16605	0.695515	11.13844
9	0.020702	88.16540	0.695671	11.13893
10	0.020702	88.16515	0.695683	11.13917
Variance Decomposition of MRETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.010927	0.525355	98.01818	1.456464
2	0.014093	26.12851	59.63315	14.23834
3	0.014933	24.10217	53.12460	22.77323
4	0.015008	23.88237	53.06301	23.05463
5	0.015020	23.85377	53.11510	23.03113
6	0.015029	23.82501	53.07404	23.10095
7	0.015030	23.83004	53.06631	23.10365
8	0.015032	23.82589	53.05850	23.11561
9	0.015032	23.82571	53.05858	23.11571
10	0.015032	23.82562	53.05841	23.11597
Variance Decomposition of DOWRETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.009942	9.535244	0.000000	90.46476
2	0.010041	9.470715	0.189937	90.33935
3	0.010077	9.531922	0.702702	89.76538
4	0.010109	9.488373	0.725720	89.78591
5	0.010129	9.539526	0.750981	89.70949
6	0.010131	9.533972	0.770466	89.69556
7	0.010132	9.533134	0.770477	89.69639
8	0.010133	9.533166	0.773392	89.69344
9	0.010133	9.533119	0.773782	89.69310
10	0.010133	9.533107	0.773775	89.69312

We should remember that the ordering of the variables has an effect on the impulse responses and variance decompositions, and in this case, from granger-causality test one can understand that obvious ordering of the series is Dow Jones, BIST100 and MSCI and variance decomposition has been constructed by this order.

When we consider the results of variance decomposition one can see that; interestingly, while the percentage of the errors that is attributable to own shocks in one step ahead is 100% for BIST100. For MSCI, the BIST100 series explains around 0,52% of the variation in returns, and for the Dow Jones, the BIST100 series explains around 9,53% of the variation.

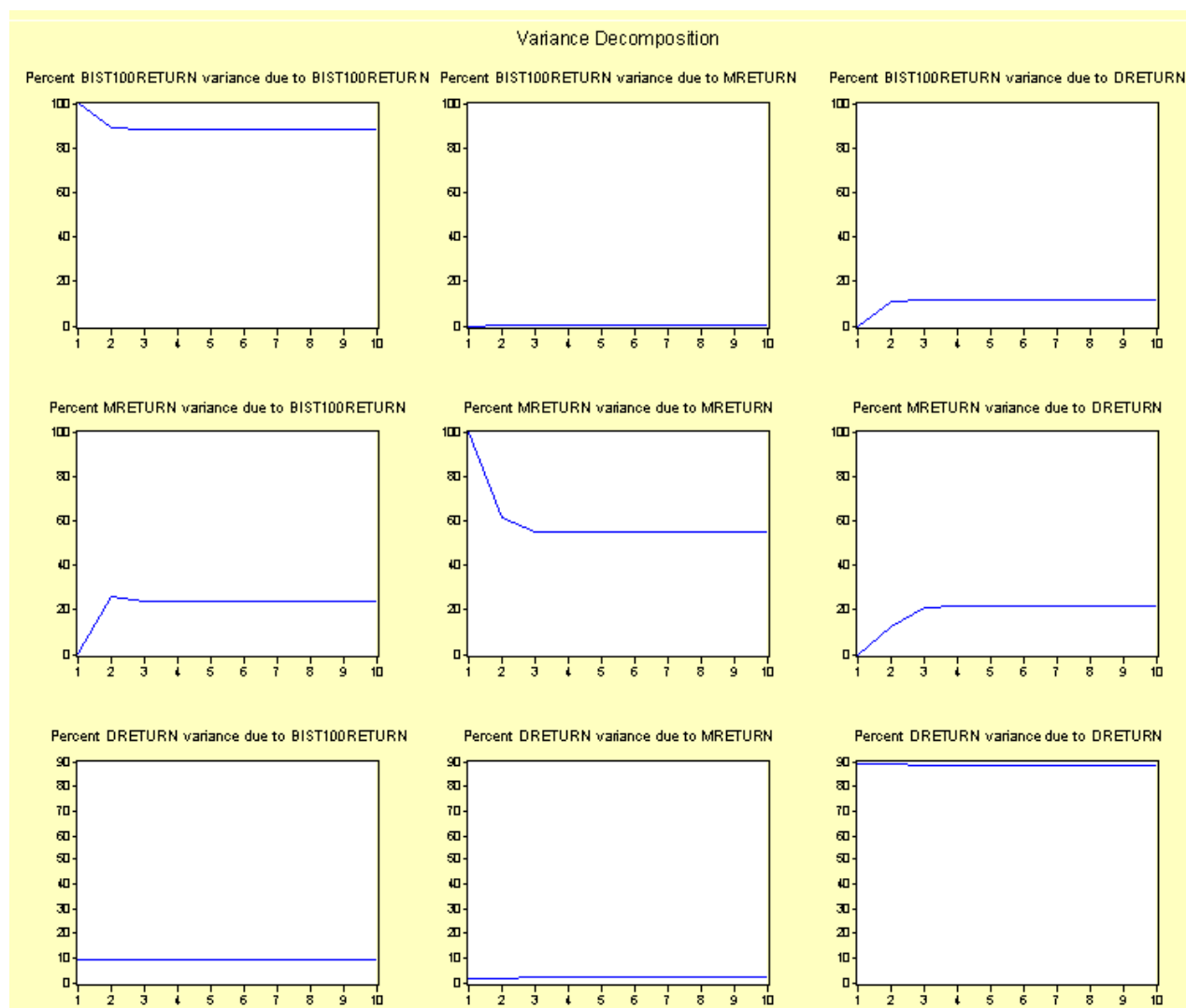
When checking VAR regression results for the period pre-Lehman Brothers' collapse, it can be seen that BIST100 is explained by its own and Dow Jones' lags and variance decomposition results have verified this results that is Dow Jones effect over BIST 100 starts from 0% to 11% similar with pre-Lehman period. As we mentioned above the ordering of the variables has an effect on the impulse responses and variance decompositions and in this case theory does not suggest an obvious ordering of the series. However we have used the ordering BIST100, Dow Jones and MSCI which is the appropriate with the result of Granger Causality tests.

II. After Lehman's Collapse

Table 6 After Lehman Variance Decomposition Simulations

Variance Decomposition of BIST100RETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.019246	100.0000	0.000000	0.000000
2	0.019842	95.13077	3.690042	1.179193
3	0.019979	93.83087	4.836234	1.332891
4	0.019983	93.80715	4.860432	1.332420
5	0.019986	93.79223	4.875634	1.332132
6	0.019986	93.79183	4.875746	1.332421
7	0.019986	93.79172	4.875857	1.332424
8	0.019986	93.79170	4.875878	1.332424
9	0.019986	93.79170	4.875879	1.332425
10	0.019986	93.79170	4.875879	1.332425
Variance Decomposition of MSCIRETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.016027	6.785409	0.868984	92.34561
2	0.019629	23.03183	14.36023	62.60794
3	0.019978	24.26399	15.25748	60.47853
4	0.020035	24.24176	15.60193	60.15631
5	0.020038	24.24543	15.59868	60.15588
6	0.020038	24.24487	15.60081	60.15432
7	0.020038	24.24518	15.60223	60.15258
8	0.020038	24.24519	15.60225	60.15256
9	0.020038	24.24519	15.60225	60.15256
10	0.020038	24.24519	15.60226	60.15255
Variance Decomposition of DOWRETURN:				
Period	S.E.	BIST100RETURN	MSCIRETURN	DRETURN
1	0.015590	27.33742	72.66258	0.000000
2	0.015678	27.15075	72.15918	0.690074
3	0.015687	27.15000	72.13948	0.710522
4	0.015696	27.16221	72.12759	0.710198
5	0.015696	27.16288	72.12625	0.710876
6	0.015696	27.16277	72.12620	0.711035
7	0.015696	27.16275	72.12622	0.711034
8	0.015696	27.16276	72.12621	0.711035
9	0.015696	27.16276	72.12621	0.711035
10	0.015696	27.16276	72.12621	0.711035

For the period after the collapse of Lehman Brothers', while the percentage of the errors that is attributable to own shocks is 100% in the case of the BIST100, for the MSCI, the BIST100 series explains around 6,75% of the variation in returns, and for the Dow Jones, the BIST100 series explains around 27,33% of the variation. When checking VAR2 regression results one see that BIST100 is explained by MSCI and Dow Jones lags. And variance decomposition results have verified this results



SECTION 5:

Volatility Modelling By Using Diagonal Vech Method

Pre-Lehman Period:

Estimation Command:

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ARCH(DERIV=AA, B) @DIAGVECH C(INDEF) ARCH(1,INDEF) GARCH(1,INDEF)
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Estimated Equations:

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DOW_RETURN = C(1)

MSCI_RETURN = C(2)

XU100_RETURN = C(3)

Substituted Coefficients:

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DOW_RETURN = 0.000526577410004

MSCI_RETURN = 0.00148083624217

XU100_RETURN = 0.000861728833532

Variance-Covariance Representation:

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GARCH = M + A1.*RESID(-1)*RESID(-1)' + B1.*GARCH(-1)

Variance and Covariance Equations:

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GARCH1 = M(1,1) + A1(1,1)*RESID1(-1)^2 + B1(1,1)*GARCH1(-1)

GARCH2 = M(2,2) + A1(2,2)*RESID2(-1)^2 + B1(2,2)*GARCH2(-1)

GARCH3 = M(3,3) + A1(3,3)*RESID3(-1)^2 + B1(3,3)*GARCH3(-1)

COV1_2 = M(1,2) + A1(1,2)*RESID1(-1)*RESID2(-1) + B1(1,2)*COV1_2(-1)

COV1_3 = M(1,3) + A1(1,3)*RESID1(-1)*RESID3(-1) + B1(1,3)*COV1_3(-1)

COV2_3 = M(2,3) + A1(2,3)*RESID2(-1)*RESID3(-1) + B1(2,3)*COV2_3(-1)

Substituted Coefficients:

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GARCH1 = 1.2174216377e-06 + 0.0406039064062*RESID1(-1)^2 + 0.948878147102*GARCH1(-1)

GARCH2 = 1.29344885098e-05 + 0.119142785826*RESID2(-1)^2 + 0.822568965634*GARCH2(-1)

GARCH3 = 5.53947230356e-05 + 0.0982021691591*RESID3(-1)^2 + 0.768953617292*GARCH3(-1)

COV1_2 = -5.87763018082e-07 + 0.0144229094709*RESID1(-1)*RESID2(-1) + 0.873342782176*COV1_2(-1)

COV1_3 = 8.04287122405e-07 + 0.00344792410732*RESID1(-1)*RESID3(-1) + 0.983372727995*COV1_3(-1)

COV2_3 = 3.86147351665e-06 - 0.00377738811086*RESID2(-1)*RESID3(-1) + 0.921771214851*COV2_3(-1)

In order to model the interconnectedness of the variables BIST100, MSCI and Dow Jones we have used the Multivariate GARCH model. More specifically we tried to model the variance of each disturbance by GARCH(1,1) process and diagonal vech method. One can see above the results of GARCH(1,1) estimations of the disturbance terms for pre-Lehman period. Below we can see the GARCH equations;

Table 7 Multivariate GARCH Equations

$$\text{GARCH (Dow)} = 1.2174216377\text{e-}06 + 0.0406039064062 * \text{RESID1}(-1)^2 + 0.948878147102 * \text{GARCH Dow}(-1)$$

$$\text{GARCH (MSCI)} = 1.29344885098\text{e-}05 + 0.119142785826 * \text{RESID2}(-1)^2 + 0.822568965634 * \text{GARCH MSCI}(-1)$$

$$\text{GARCH (XU100)} = 5.53947230356\text{e-}05 + 0.0982021691591 * \text{RESID3}(-1)^2 + 0.768953617292 * \text{GARCH XU100}(-1)$$

As one can see from the equations constant term of XU100 is the biggest one among MSCI and Dow Jones, that means with respect to MSCI and Dow most part of the volatility of XU100 is explained by the constant term. In other words most of XU100's volatility can not be explained by its one lag residuals and one lag volatility estimation. When we compare the variables within themselves we see that Dow's volatility estimations were much more affected by its one lag volatility estimation rather than its one lag residuals. Similar situations exist for other variables that means their volatility estimations were much more affected by their one lag volatility estimation rather than their one lag residuals.

CONCLUSION

As a result, before the collapse of Lehman Brothers MSCI did not affect BIST100 movements because in general emerging market indexes are much more affected by global events rather than their local news flow and since Turkey's economical condition is much more fragile mostly because of political instability and high current account deficit risk, BIST 100 reacts to global news more quickly than the emerging markets in this period. This may be a sign that Turkey was the weakest link of the emerging market league before Lehman's collapse. Second conclusion that can be derived is that, in Turkey proportion of short run foreign investments namely portfolio investments before the collapse of Lehman Brothers were higher with respect to other emerging markets. This can be considered as a sign of unstable economic conditions and high volatile market. Another deriving is that Turkey should not be considered as an emerging market according to precrisis period data.

During pre-Lehman period when we consider the VAR equation in which Dow Jones index is dependent variable, we see that as expected only first lag of Dow Jones affects itself and this conclusion is also verified by Granger Causality test. As a result since just one lag of Dow affects itself, one concludes that DOW can be modelled by AR(1) that means Dow behaves much more in a random walk manner than MSCI and BIST100. In other words this means that all past information has been priced so that it is enough to use first lag to make the best prediction for the future movement of Dow and also one can conclude that Dow market is more efficient than MSCI and BIST 100 because of its almost random walk property.

Decrease in the lag number in VAR regression model with respect to pre-Lehman period can be considered as a sign for evolving to an efficient market of BIST100 after the collapse of Lehman Brothers because in our opinion a model in which it incorporates all information in shorter memory, is more efficient and more close to random walk.

An interesting point to note is that the coefficient of first lag of BIST100 is negative and statistically significant meaning that if we consider the effect of BIST100 and neglect other factors when BIST100 closes the day positive one should expect that BIST100 will close negative in the following day. Similarly when we only consider the effect of Dow Jones, as expected, Dow has positive effect on BIST100 that is while Dow increases one should expect also an increase in BIST100 the following day. This situation also is valid for MSCI and DOW that means if one index increased in a day then the other day index will most probably will decrease. The reason for this fact is that we are dealing with daily returns that means short time period data so investors consider an increase as an opportunity to realize their profit and any decrease will be considered as potential for entering the market. In fact some of researchers have investigated that the market has a tendency to increase after the week of bad news release. The reason for this phenomenon may be related with our case.

After Lehman's collapse, the most important change in the model is that BIST100 own lags do not affect itself anymore and MSCI is an explanatory variable for BIST100 return. What is the meaning of this change? In our opinion this change can be considered as a sign that Turkey is not the weakest link of emerging market league anymore, in fact it may be the one of the strongest members and also proportion of long run foreign investments in Turkey after the collapse of Lehman Brothers were higher with respect to other emerging markets and also this change can be considered as a sign of more stable economic conditions and lower volatile market with respect to

pre-Lehman period. In fact recently Fitch and Moody's have hiked Turkey's ratings to investment grade and so these rate hikes confirm our derivings.

Another change in VAR regression results is that MSCI becomes an explanatory index for both of Dow Jones and BIST100 after Lehman collapse whereas this situation was not valid for pre-Lehman period. In our opinion this means that after 2008 crisis emerging markets effectiveness on global economic system have increased because of the fact that under heavy debt burden developed economies growth rates have declined significantly and austerity measures has slowed down the economic recovery. In fact when the amount of debt of developed countries is considered, it can easily be understood that their natural economic growth rates won't be reached even after long years. Thus emerging markets growth figures will overperform the developed countries in the following years so in fact becoming an explanatory index for both of Dow Jones and BIST100 of MSCI is the effect of this rebalancing over financial markets.

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