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Estimating Spillover Effect and Leverage Effect Using EGARCH-ARMA Approach in Mongolian Stock Exchange

Cheng-Wen Lee, Dolgion Gankhuyag*

Department of International Business, College of Business, Chung Yuan Christian University
200 Chung Pei Road, Chung Li District, Taoyuan City, 32023, Taiwan, ROC

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Abstract

This study checked the spillover effect and leverage effect from 2 January 2012 to 27 December 2017 in the Mongolian Stock Index MSE20 time frame. We found spillover effect on individual stock prices from the market index, but our analysis did not support individual stock has a spillover effect on stock index. In terms of volatility, only market and stock volatility have a bilateral spillover effect. Stock index in particular has a much stronger influence on stock price. Our research did not support previous studies for the leverage effect of the EGARCH-ARMA method, suggesting negative asymmetric influence of volatility such that two financial instruments overlap in their value.

1. INTRODUCTION

During the transitional period from a centrally planned economy to a market economy in Mongolia, on January 18, 1991, Mongolian Stock Exchange (MSE) was established by the Government of Mongolia with the purpose of introducing its Privatization Policy and expanding the investment and securities industry. Registered companies are classified as marketable, daily average trading, number of trading days, and decentralization according to the "Securities Price Index Computation Regime" of the MSE. The market index MSE20, the list of the TOP-20 is set up and the portfolio is revised every year.

Spillover effect was defined mostly as contagion as crossing economic transmission in economics, but it could be introduced in finance as stock trading influence affecting other stock trading. Spillover influence can be observed in all bear and bull markets. The spillover effect of stock index and stock prices was used by many authors. It is widely used to analyze the correlation between stock index returns and stock prices. The stock index displays the statistical measure of the market change in stock prices. Investors tend to use stock index to calculate the value of the market. The terms spillover, contagion, co-movement and cointegration are generally used interchangeably in the field of finance. The leverage effect refers to a propensity to be pessimistic with the asset's returns, which has been observed. The results are also usually asymmetrical: stock prices drop with higher volatility increases than the decline in volatility associated with rising stock markets. For analyzing the presence of asymmetric volatility the leverage effect that was created by price fluctuation in the cluster phenomenon on the market is essential.

The purpose of the study in Mongolian Stock Exchange is to investigate the bilateral spillover effect and leverage effect.

2. METHODOLOGY

2.1 Literature Review

Bucevska, (2013) tested the use of the Macedonian stock market and the most fitted EGARCH model. Chen and Wang (2009) used GARCH model and EGARCH model with normal distribution and student t distribution to calculate Chinese stock market (Shanghai and Shenzhen market) price at risk estimation. They stated a significant positive association between the regular returns and volatility of Shanghai and Shenzhen stock markets, and the phenomenon of volatility clustering was apparent. Lim and Sek, (2013) found that in the Malaysian stock market (1990-2010) symmetric and asymmetric GARCH models were performed differently in different time frames. They found that the symmetric GARCH model is the best in pre-and post-crisis performance. It is preferred to model asymmetric GARCH. Zhang et al., (2008) revealed that the existence of spillover effects of mean spillover, volatility spillover and risk spillover for evaluating the US dollar exchange rate on oil price using GARCH (1,1) and T-GARCH (1,1) models. In 1977-2006 W&T offshore and Brent crude oil prices, Fan et al. (2008) used

*Corresponding author. Dolgion Gankhuyag
Email address: dolgiongankhuyag@gmail.com

Autoregressive Moving Average (1,1)-GARCH (1,1)-Value at Risk and T-GARCH (1,1) and investigated the spillover effect between two markets. Interestingly, authors found no asymmetric leverage effect between the market returns of WTI and Brent, but from the study they found two ways of spillover effects.

2.2 Data

Data used in this study were Mongolian Stock Exchange (MSE) top 20 daily closing price securities and daily data on the MSE-20 stock index. All data collected from Mongolian Stock Exchange's official government public database (www.mse.mn) for the 2013-2017 period (2 Jan 2013 to 28 Dec 2017) for daily data.

2.3 Calculation and data analysis

In order to measure price difference, this study used log return.

$$R_{j,t} = \ln\left(\frac{P_{j,t}}{P_{j,t-1}}\right) \quad (1)$$

where $P_{j,t}$ is closing price of each trading day of j^{th} company.

We used logarithmic return as follows to test stock index:

$$R_{m,t} = \ln\left(\frac{X_t}{X_{t-1}}\right) \quad (2)$$

where X_t is MSE20 stock index of day *t*.

$\overline{V_{j,t}}$ is average trading volume of each trading day of j^{th} company.

For check market trends, all stock markets use their own benchmarks and use them for investors for test portfolio results. If stock indices determine market fluctuations, stock prices in the same stock exchange may be affected. This segment will cover the model for block trading and includes the spillover effect. Unlike Chen and Huang, EGARCH-ARMA design (2010) has been created.

The spillover effect in returns in the MSE stocks are the following:

$$R_{i,t}^c = \alpha_0 + \sum_{i=1}^{g} \alpha_1 R_{i,t-i}^c + wR_{t-1}^m + \varepsilon_{i,t}^c + \sum_{i=1}^{s} \theta_i \varepsilon_{i,t-i}^c$$

$$\log(h_{i,t}^{c^2}) = a + \sum_{i=1}^{p}(a_1|\frac{\varepsilon_{i,t-i}^c}{h_{i,t-i}^c}| + \delta_1 \frac{\varepsilon_{i,t-i}^c}{h_{i,t-i}^c}) + \sum_{i=1}^{q} \psi_i \log(h_{i,t-i}^{c^2})$$

$$, \varepsilon_{i,t}^c|\psi_{t-1} \sim N(0, h_{i,t}^c).$$

The spillover effect in returns in the MSE market index are the following:

$$R_t^m = \beta_0 + \sum_{i=1}^{g} \beta_1 R_{t-i}^m + dR_{i,t-1}^c + \varepsilon_t^m + \sum_{i=1}^{s} \gamma_i \varepsilon_{t-i}^m$$

$$\log(h_t^{m^2}) = b_0 + \sum_{i=1}^{p}(b_1|\frac{\varepsilon_{t-i}^m}{h_{t-i}^m}| + \delta_1 \frac{\varepsilon_{t-i}^m}{h_{t-i}^m}) + \sum_{i=1}^{q} \varsigma_i \log(h_{t-i}^{m^2})$$

$$\varepsilon_t^m|\psi_{t-1} \sim N(0, h_t^m)$$

Here null hypothesis that no spillover effect (w=0, d=0) against alternative H1 which for spillover effect will exist (w$\neq 0,\ d \neq 0$),

where $R_{i,t}^c$ stock returns at the period *t*

$\sum_{i=1}^{g} \alpha_1 R_{i,t-i}^c$ higher order of the autoregressive AR(g) for stock returns

$\varepsilon_{i,t}^c$ stock returns residual at the period *t*

$\sum_{i=1}^{s} \theta_i \varepsilon_{i,t-i}^c$ higher order moving average mean process MA(s) for stock returns at the period *t*

$\sum_{i=1}^{q} a_1 \varepsilon_{i,t-i}^{c^2}$ q order of the ARCH term for stock returns at the period *t*

$\sum_{i=1}^{p} \psi_i h_{i,t-i}^c$ p order conditional heteroscedasticity of EGARCH term for stock returns at period *t*

δ_1 leverage term

θ_i unknown parameter

The spillover effect of volatility in stocks are the following:

$$R_{i,t}^c = \alpha_0 + \sum_{i=1}^{g} \alpha_1 R_{i,t-i}^c + \varepsilon_{i,t}^c + \sum_{i=1}^{s} \theta_i \varepsilon_{i,t-i}^c$$

$$\log(h_{i,t}^{c^2}) = a_0 + \sum_{i=1}^{p}(a_1|\frac{\varepsilon_{i,t-i}^c}{h_{i,t-i}^c}| + z_1 \frac{\varepsilon_{i,t-i}^c}{h_{i,t-i}^c}) + \sum_{i=1}^{q} \psi_i \log(h_{i,t-i}^{c^2}) + v\varepsilon_{t-1}^{m^2}$$

$$\varepsilon_{i,t}^c|\psi_{t-1} \sim N(0, h_{i,t}^c)$$

$$R_t^m = \beta_0 + \sum_{i=1}^{g} \beta_1 R_{t-i}^m + \varepsilon_t^m + \sum_{i=1}^{s} \gamma_i \varepsilon_{t-i}^m$$

$$\log(h_t^{m^2}) = b_0 + \sum_{i=1}^{p}(b_1|\frac{\varepsilon_{t-i}^m}{h_{t-i}^m}| + \delta_1 \frac{\varepsilon_{t-i}^m}{h_{t-i}^m}) + \sum_{i=1}^{q} \varsigma_i \log(h_{t-i}^{m^2}) + l\varepsilon_{i,t-1}^{c^2}$$

$$\varepsilon_t^m|\psi_{t-1} \sim N(0, h_{i,t}^m)$$

Here null hypothesis that no spillover effect (v=0, l=0) against alternative H1 which for spillover effect will exist (v$\neq 0,\ l \neq 0$),

where R_t^m market index at the period *t*

$\sum_{i=1}^{g} \beta_1 R_{t-i}^m$ higher order of the autoregressive AR(g) for market index

ε_t^m market index residual at the period *t*

$\sum_{i=1m} \gamma_i \varepsilon_{t-i}^m$ higher order moving average mean process MA(s) for market index at the period *t*

$\sum_{i=1}^{q} b_1 \varepsilon_{t-i}^{m^2}$ q order of the ARCH term for market index at the period *t*

$\sum_{i=1}^{p} \varsigma_i h_{t-i}^m$ p order conditional heteroscedasticity of EGARCH term for market index at period *t*

z_1 leverage term

γ_i unknown parameter

3. RESULTS AND ANALYSIS

For statistical bases, Table 1 summarize the datasets statistics. All the data and observations are collected from same period of time and observation numbers are equal. 11 out of 20 securities average daily returns are positive and BNG and TCK have lowest standard deviations. In order to show the data is compatible for normal distribution, standardized Skewness, Kurtoss measures and Jarque-Bera test were provided. According to Jarque-Bera statistics shows normal distribution of residuals cannot be rejected in this study.

Table 1
Type of dashboard according to Eckerson (2005)

Name	Type	Period	Obs	Mean	SD	Skewness	Kurtosis	Jarque-Bera
ADL	Stock	2012/1/2-2017/12/27	1301	0.000394	0.033192	-0.1422	9.3417	2184.505***
APU	Stock	2012/1/2-2017/12/27	1301	-0.001305	0.065606	-28.6059	956.9238	49505423***
BAN	Stock	2012/1/2-2017/12/27	1301	0.000669	0.032420	-0.0750	8.1536	1440.963***
BDS	Stock	2012/1/2-2017/12/27	1301	-0.000941	0.023802	-1.0458	22.0553	19920.36***
BNG	Stock	2012/1/2-2017/12/27	1301	-0.000058	0.019413	0.2605	27.8835	33579.99***
EER	Stock	2012/1/2-2017/12/27	1301	0.001537	0.039193	25.4461	648.5015	22727507***
GOV	Stock	2012/1/2-2017/12/27	1301	0.002306	0.047983	20.7526	431.6690	10054549***
GTL	Stock	2012/1/2-2017/12/27	1301	0.001072	0.026184	0.6283	19.9156	15596.61***
HGN	Stock	2012/1/2-2017/12/27	1301	-0.000720	0.032373	0.2306	12.3248	4725.02***
HRM	Stock	2012/1/2-2017/12/27	1301	0.000262	0.025409	-0.2032	16.5403	9947.547***
JTB	Stock	2012/1/2-2017/12/27	1301	-0.000720	0.032373	0.2306	12.3248	4725.02***
MCH	Stock	2012/1/2-2017/12/27	1301	-0.001034	0.031160	-0.4415	12.2379	4585.824***
MIE	Stock	2012/1/2-2017/12/27	1301	0.000526	0.028439	0.1353	16.3849	9715.692***
MMX	Stock	2012/1/2-2017/12/27	1301	0.000404	0.024555	0.2888	10.6708	3207.774***
NEH	Stock	2012/1/2-2017/12/27	1301	0.000960	0.026619	-0.0901	17.7736	11833.27***
SHG	Stock	2012/1/2-2017/12/27	1301	-0.001110	0.033153	-0.2579	10.0777	2729.901***
SUU	Stock	2012/1/2-2017/12/27	1301	-0.004403	0.189647	-35.2675	1262.7210	86292717***
TCK	Stock	2012/1/2-2017/12/27	1301	0.000634	0.021315	0.4446	15.3422	8300.39***
TTL	Stock	2012/1/2-2017/12/27	1301	-0.000012	0.035527	0.4722	7.6628	1226.921***
UID	Stock	2012/1/2-2017/12/27	1301	0.000154	0.033758	-0.0865	8.6989	1759.434***
MSE20	Index	2012/1/2-2017/12/27	1301	0.000102	0.011197	0.2518	10.9412	3432.257***

Table 2 revealed that 99 percent of the significance of Augmented Dickey-Fuller unit-root testing time series is stationary. Schwarz Criterion was used and tested by the Lagrange Multiplier method to pick the most suitable ARMA and EGARCH methods. For the EGARCH method, ARCH-LM tests were used to determine whether or not the data had an ARCH effect. Many stock returns are small at 1 percent level in terms of contingent variability benefit, and all of the significant ones have a positive effect in lagged inventions. According to the EGARCH-ARMA model, nearly all of the effect (leverage) is significant but positive. Previous studies found a mostly negative leverage effect and the authors predict it.

Table 2.
Summary statistics of the stock and stock index returns unit-root, LM and ARCH-LM tests

Name	Type	ADF	ARMA	SBC	LM	ARCH-LM	EGARCH	SBC	ARCH-LM
ADL	Stock	-35.512***	(2, 2)	-3.957	2.455	44.483***	(1, 1)	-4.035	1.785
APU	Stock	-37.537***	(1, 1)	-2.596	0.077	0.001	(1, 2)	-5.304	0.001
BAN	Stock	-27.473***	(2, 1)	-4.007	0.270	15.555***	(3, 3)	-4.085	1.148
BDS	Stock	-35.577***	(1, 1)	-4.622	0.427	8.803***	(3, 2)	-4.743	0.262
BNG	Stock	-36.206***	(2, 3)	-5.029	0.153	4.683***	(3, 3)	-5.262	0.131
EER	Stock	-24.071***	(1, 1)	-4.522	0.293	8.404***	(1, 2)	-4.597	0.752
GOV	Stock	-32.260***	(1, 4)	-4.603	0.657	35.324***	(2, 1)	-4.890	0.242
GTL	Stock	-37.310***	(1, 1)	-4.433	0.163	7.129***	(1, 1)	-4.556	0.350
HGN	Stock	-35.223***	(3, 2)	-4.009	1.009	27.363***	(1, 1)	-4.125	1.323
HRM	Stock	-40.256***	(2, 0)	-4.503	0.030	7.861***	(3, 3)	-4.686	0.217
JTB	Stock	-35.229***	(1, 1)	-4.012	0.837	36.525***	(3, 3)	-4.151	2.345
MCH	Stock	-27.968***	(2, 1)	-4.090	0.046	11.774***	(3, 2)	-4.149	1.045
MIE	Stock	-34.364***	(1, 0)	-4.273	0.098	5.532***	(1, 3)	-4.381	0.073
MMX	Stock	-43.087***	(2, 3)	-4.589	0.261	6.339***	(3, 3)	-4.708	0.022
NEH	Stock	-37.079***	(1, 1)	-4.409	0.282	10.501***	(2, 1)	-4.662	0.536
SHG	Stock	-37.761***	(1, 0)	-3.967	0.582	23.722***	(3, 3)	-4.036	0.136
SUU	Stock	-35.940***	(1, 1)	-0.471	0.014	0.001	(1, 0)	-0.454	0.001
TCK	Stock	-40.153***	(1, 2)	-4.861	0.917	11.032***	(2, 2)	-5.020	0.019
TTL	Stock	-21.366***	(1, 1)	-3.854	0.773	58.852***	(1, 2)	-4.037	0.482
UID	Stock	-20.528***	(2, 1)	-3.968	0.336	71.025***	(1, 2)	-4.146	1.593
MSE20	Index	-33.188***	(1, 1)	-6.145	0.388	124.336***	(2, 2)	-6.276	1.829

Note:
ADF is the t-statistic for the Augmented-Dickey-Fuller test with a constant and trend at the level. LM is Breusch-Godfrey serial correlation test and we used Lag (2) to be the best lag-period. SBC is Schwarz Criterion.
***, ** and * indicate at α=1, 5 and 10% levels of significance respectively.

Table 3 also shows us the market index of how ADL (24.7%), HGN (35.69%) and JTB (30%) have an effect on individual stock values. On the other hand, how does the stock index impact individual stocks? From Table 4, few ADL, BDS, GTL and TTL shares can have little impact at stock index from both of our models. The stock index consisted of 20 individual stocks, some of which had a real impact on their index.

Table 4 reveals that how stock index volatility impact to stocks price and also shows the opposite and almost all effects are important, leading us to conclude a bilateral spillover effect on volatility of stock prices and stock indexes. Surprisingly, most of the results are significant findings.

Table 5 revealed that most of the stocks volatilities affecting market index. It is clear that market index itself consisted basket of stock and logical to understand it can be affected stocks fluctuations. From the result, we can see that all of the stocks significantly effect to market.

Table 3.
EGARCH-ARMA result for stocks

Name	α_0	α_1	α_2	α_3	w	θ_1	θ_2	θ_3	θ_4	a_0	δ_1
ADL	0.0008	-0.3293	0.4900		0.2476***	0.2493	- 0.5989			-0.2931	0.0877***
APU	0.0011	-0.0203			0.0972	-0.0121				-5.4723	-0.1306**
BAN	0.0014	-0.0944	-0.1250		-0.219***	0.0256				-0.8968	-0.064***
BDS	-0.0024	-1.0012			0.1883***	1.0061				-2.1773	0.0265**
BNG	-0.0008	0.1102	0.8568		0.1006***	-0.0551	- 0.8756	-0.0823		-1.0840	0.1153***
EER	0.0004	0.8692			0.1407***	-0.9487				-0.5199	0.0703***
GOV	0.0002	-0.9985			0.0644	0.8971	- 0.0847	0.0684	0.0532	-1.1143	0.0217**
GTL	0.0015	-0.0281			0.0955**	0.0798				-2.2080	0.2858***
HGN	-0.0014	1.2725	-0.3721	0.0553	0.3569***	-1.3471	0.3591			-1.1702	-0.0055
HRM	0.0006	-0.1015	-0.0379		0.0242					-1.4452	-0.0141**
JTB	-0.0022	-0.7055			0.3002***	0.7355				-3.6006	0.0226***
MCH	-0.0007	0.8847	-0.0174		0.0278	-0.9162				-1.3144	0.0452***
MIE	0.0005	0.0058			-0.0204					-7.1199	0.0101
MMX	0.0003	-0.1274	0.8585		0.1768***	-0.0455	-0.9059	0.0832		-1.7320	0.0260***
NEH	0.0007	0.8619			0.1993***	-0.9575				-0.9453	0.0889***
SHG	-0.0014	-0.0869			0.1397**					-4.2184	0.1309***
SUU	0.0104	-0.9414			-2.86***	0.9587				-3.9***	-1.918***
TCK	0.0006	-0.1918			0.126***	0.0543	-0.0426			-0.8915	0.068***
TTL	-0.0024	0.6851			0.0691	-0.6656				-1.6625	0.0181
UID	0.0001	0.6210	0.0122		0.1994***	-0.8617				-0.2442	0.0693***

Table 4.
Spillover effect to stock market index and spillover effect of volatilities on MSE stocks.

Spillover effect to stock market index		**Spillover effect of volatilities on MSE stocks**	
ADL	0.00154	ADL	707.709***
APU	-0.01586	APU	4.55000
BAN	-0.00806	BAN	250.633***
BDS	0.02901***	BDS	1033.809***
BNG	0.02083	BNG	99.433***
EER	0.01251	EER	-31.953*
GOV	-0.00089	GOV	737.564***
GTL	0.02019***	GTL	194.321***
HGN	0.00569	HGN	377.155***
HRM	0.00309	HRM	-157.410***
JTB	0.00574	JTB	408.048***
MCH	0.00481	MCH	-206.997***
MIE	0.00662	MIE	238.874***
MMX	-0.00615	MMX	564.327***
NEH	0.01272	NEH	474.439***
SHG	-0.00713	SHG	942.638***
SUU	-0.00548	SUU	2795.625***
TCK	-0.00394	TCK	77.442**
TTL	0.01889***	TTL	1469.141***
UID	0.00707	UID	259.758***

Note: ***,** and * indicate at α=1, 5 and 10% levels of significance respectively.

Table 5.
Spillover effect of volatilities on stock market index.

	ADL	APU	BAN	BDS	BNG
EGARCH	2.12010***	-0.19823	-0.63671	-2.2002***	3.3059***
	EER	**GOV**	**GTL**	**HGN**	**HRM**
EGARCH	0.09008	1.10612**	-3.726***	-1.53222**	1.5402**
	JTB	**MCH**	**MIE**	**MMX**	**NEH**
EGARCH	-1.7927***	0.95967	-0.847***	-0.8369***	-0.84308
	SHG	**SUU**	**TCK**	**TTL**	**UID**
EGARCH	-1.18604**	-0.04365	4.12489	1.0054***	0.6474***

Note: ***,** and * indicate at α=1, 5 and 10% levels of significance respectively.

4. CONCLUSIONS

We obtained spillover effect on each individual stock price from the market index, but our study did not support individual stock has a spillover effect on stock index. The index itself consists of 20 stocks but each stock does not work on the market equally, which shows that most securities do not have a spillover effect on the market.

The lagged volatility from stock index and shares have a favorable effect in terms of volatility. This study supports both equity and stock price bilateral spillover effects. Stock index in particular has a much stronger influence on stock price.

Our study did not support previous studies for the leverage effect of the EGARCH-ARMA model, showing negative asymmetric effect of volatility showing that two financial instruments converge in their value.

5. LIMITATION

For several years, the research used only trading information on the Mongolian Stock Exchange with only EGARCH-ARMA model. More specific models are recommended.

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