Volume 8 Number 2 2009

Volatility Spillover between Stock Market and Foreign Exchange Market in Indonesia

Sudarso Kaderi Wiryono
Yohanes Edward Widjonarko

School of Business and Management
Institut Teknologi Bandung

Abstract

Foreign exchange rate risk is one of the market risk factors that affects investments. Understanding the foreign exchange risk exposure of each sector is necessary to set foreign exchange risk management. This paper examines the volatility spillover effect between the stock market and foreign exchange rate market. The significant volatility spillover existence is an evident that the volatility in one market affects the volatility in the other market. This research used EGARCH volatility spillover model developed by Malhotra, Niranjan, and Swain (2007) in India's study case. The model is applied to examine the volatility spillover of foreign exchange market toward each sector indices in Indonesia. The findings of the research are that USD/IDR fluctuation gives the most significant exposure to Indonesian stock market's on JSX indices as well as on the majority sectors, followed by JPY/IDR fluctuation and EUR/IDR fluctuation, while GBP/IDR does not give a significant volatility spillover toward the sector. Most sectors also have a different exposure one another so different focus of foreign exchange risk management is needed.

Keywords: foreign exchange risk, volatility spillover, risk management

1. Introduction

In this globalize market, everything is connected. An impact on one country may take affect to others. The same thing happens in the economic world. Companies and investors must face the fact that their investments are connected and exposed to the risk from the global market condition. Internationalization of stock market, liberalized cash flows, foreign investment, and global foreign trading make the country economic becomes connected with the global economy.

The same thing happens in Indonesia, we are very connected to the global economy. Take an example to the recent event of U.S. recession. The impact of the recession in United State due to the sub prime mortgage crisis is spread to all over the world, including Indonesia, resulting in the significant decrease on the stock price indices and performance on many economic sectors.

Indonesia export to US contributes 14% to Indonesian economy. Bappenas stated that due to the recession there is possibility that U.S. will cut down the import from Indonesia to USD 2 billions this year.[1] This situation consequently will give negative impact to our economy. The recession also causing significant investment cut down from the investors as a consequent to the increase of risk perception on emerging market investment. Consequently the IHSG becomes unstable. In 22 January 2008, the IHSG falling down 7.7% (191.5 points) this is very contradicting with the situation before the recession when IHSG achieved the highest level. This phenomenon shows us that Indonesia economic are exposed to the fluctuation in US and very connected with the US economy.

From illustrations above, managers and investors should not only focus in handling their business risk but should aware also to the market risk. There are several types of market risk. One of the important risks that give significant effect to economic sectors is the foreign exchange fluctuation risk. It has been observed that exchange rate has been used to explain the behavior of stock prices, on assumption that corporate earnings tend to respond to the exchange rate fluctuations (Kim, 2003).

Before setting the strategy it is important for us to fully understand about the characteristic of spillover effect in our country. For that reason the main goal of this research is to understand. Whether there is a significant volatility spillover from the stock market and foreign exchange market in Indonesia and vice versa the volatility spillover effect from the foreign exchange market toward the stock market in Indonesia. In this sense, we would like to determine the significant volatility spillover effect from USD/IDR, GBP/IDR, JPY/IDR and EUR/IDR to each sector in Indonesia. This can assist the risk manager, investors and government with risk exposure database from each currency and could focus on significant currency on their investment or business. Hopefully, with this research, managers, investors, and government can have more insight in the movement of foreign exchange and its effect to the stock market. With a proper understanding of the inter market volatility investors, companies, and the government can set a better risk management strategies to mitigate the risk of the fluctuation in the financial market, especially the risk of exchange rate volatility.

2. Literature Review

Volatility spillover effect is a condition of volatility on one variable that produce volatility on others variable. In economic, the volatility spillovers term is used to define a condition of transmission of turbulence from one market to other market. The effect occurs when changes in price volatility in one market produce a lagged impact on volatility in other markets over and above local effects (Millunovich, Thorp, 2005). The study of volatility spillover effect was pioneered by Engel (1982) using ARCH-GARCH framework, further developed by Bollerslev (1986), Nelson (1991), and many others.

1) http://www.kompas.com/kompascetak/read.php?cnt=.kompascetak.xml.2008.01.24.03440843&channel=2&mn&idx=2

In stock market, we understand that fluctuation of many economic factors affecting the fluctuation of the stock price, for instance: exchange rate, interest rate, other country stock price indices, and many more. These factors have been studied by many experts as an evidence of volatility spillover effects on the financial world. For example volatility between equity market researched by Hamao, Masulis, and Ng in 1990 and further research by Lin, Engle, and Ito (1994), volatility spillover on bond market by Christiansen (2003), exchange rates by Engle, Ito and Lin (1990) and Baillie and Bollerslev (1990), equity and exchange rates (Apergiz and Rezitis 2001.)

Foreign currency exchange rate is one of important aspect that affects the fluctuation of country economy, as well as affecting the stock market price indices of the country. Export number, foreign investment, international cash flows, and globalize stock market make the foreign exchange very closely interrelated with the stock market.

Some previous study has strengthened the argument, for example Kim (2003) stated on his study that it has been observed that exchange rate has been used to explain the behavior of stock prices on the assumption that corporate earnings tend to respond to the fluctuation in exchange rate. Other analyst argues that the turbulence happened because there is information shocks transmitted across the financial markets (Fleming, Kirby, and Ostdiek, 1998). The information flow change affects the market sentiment and drives the investors in other financial market to change their investment strategy.

Fang and Miller in 2002 study showed that there is bidirectional causality between the Korean foreign exchange market and Korean Stock market. Their study also concluded that depreciation of exchange rate positively affects stock market returns and stock market return responds to exchange rate depreciation volatility.

Although the studies proven there is adequate evidence of existence of the bidirectional relationship between the market we must understand that not every market have the same volatility spillover effect. Some country may have a strong volatility spillover effect, some other may have only weak spillover effect, even there is countries that do not show to get the impact at all. Kanas (2000) study proven the condition, in his research he investigate the effect on six industrialized counties which are US, UK, Japan, Germany, France, and Canada. The study shows that each of the country gives a different result of degree of volatility impact. The study showed there is co-integration between stock prices and exchange rate, the volatility spillover from stock returns to exchange rate returns happened except for German.

3. Methodology

It has been argued that financial time series data has a characteristic of non normal distribution and heterocedasticity (time varying variance). Therefore using a simple linear regression model which assumed the data as homocedastic and normal distributed will result in bias and unreliable outcome. ARCH (*autoregressive conditional heterocedasticity*) model, which was developed by Robert F. Engle, is more suitable for analyzing time series data with time varying variance. For financial time series data with high fluctuation, auto correlation model with time varying variance is a more suitable and realistic model compare to the constant variance auto correlation model (ie. basic auto regressive, moving average model) (Surya, 2003).

Volatility based on ARCH(p) model assumed that the variance fluctuation is affected by p-number of previous data fluctuation. GARCH stands for *generalized autoregressive conditional heteroscedasticity* is a further development of ARCH model by Bollerslev in 1986. GARCH is a model that includes past variances in the explanation of future variances. More specifically, GARCH is a time-series technique that you use to model the serial dependence of volatility. It takes into account excess kurtosis (fat tail behavior) and volatility clustering, two important characteristics of financial time series. It provides accurate forecasts of variances and covariance's of asset returns through its ability to model time-varying conditional variances. (MATLAB literature, 2008).

Volatility based on GARCH (p,q) model assumed that variance fluctuation is affected by p-number of fluctuation and q-number of previous volatility. GARCH (1,1) model then assumed that the data variance is affected by 1 previous data fluctuation and 1 previous volatility (Bollerslev, 1986).

The EGARCH stands for *Exponential generalized autoregressive conditional heteroscedasticity*, a model was proposed by Nelson (1991). Nelson and Cao (1992) argue that the non negativity constraints in the linear GARCH model are too restrictive. One of the restrictions in GARCH model is that the model enforces a symmetric response of volatility to positive and negative shocks (Mishra, Swain, Malhotra, 2007), this is contradictory to the financial time series data which usually contain a leverage effect. In EGARCH, the model contains leverage term to capture the leverage effect in the market and used the natural log of the conditional variance. The GARCH also imposes the nonnegative constraints on the parameters, while there are no restrictions on the EGARCH model parameter. (Mishra, Swain, Malhotra, 2007).

The following is the AR(1) EGARCH (1,1) basic formula model:

$$\text{AR (1)}: y_t = c + \tau\,(y_{t-1}) + \varepsilon_t \qquad (1)$$

$$\text{EGARCH (1,1)}: \ln h_t = \omega_0 + \beta_1 \ln h_{t-1} + \alpha_1 \left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| + \phi\,\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \qquad (2)$$

Where yt is the return of the asset at period of t, c is constant, yt-1 is the previous period return at the time period t-1 and εt is the residual (white noises error term). Log *ht* is the log variance of the asset, which restricts the volatility to be positive, *ω0* is constant level of volatility. β1 ln *ht-1* explain the previous volatility effect, α1 explain the previous error effect, and ϕ explain the relationship of volatility to both positive and negative shocks (explain the leverage effect).

To study the volatility spillover between the foreign exchange market and stock market in India, Mishra, Swain, and Malhotra in 2007 used the EGARCH function which modified with the residual of opposite market as a shock spillover effect to the market.

$$\text{AR (1): } y_t = c + \tau\,(y_{t?1}) + \varepsilon_t \tag{3}$$

EGARCH (1,1) for stock market:

$$\ln h_t(stock) = \omega_0 + \beta_1 \ln h_{t-1} + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \phi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \psi\,(resid_{erate}) \tag{3}$$

EGARCH (1,1) for exchange rate:

$$\ln h_t(erate) = \omega_0 + \beta_1 \ln h_{t-1} + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \phi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \psi\,(resid_{stock}) \tag{3}$$

Where yt is the return of the asset at period of t, c is constant, yt−1 is the previous period return at the time period t-1 and εt is the residual (white noises error term). Log *ht* is the log variance of the asset, which restricts the volatility to be positive, ω0 is constant level of volatility. β1 ln *ht-1* explain the previous volatility effect, α1 explain the previous error effect, and ϕ explain the relationship of volatility to both positive and negative shocks (explain the leverage effect). The last coefficient is the modification coefficient, ψ explains the volatility spillover coefficient. In the model they used residuals generated from the EGARCH model of other market to be introduced as a shock in examined market.

4. Data Analysis

This volatility spill over study between the stock market and the foreign exchange market in Indonesia is based on the daily closing index of IHSG and its 10 sectors indices to represent the stock price, and using the daily selling closing price of Rupiah in respect to US Dollar, Euro, Japan Yen, and Great British Pound sterling taken from the Bank Indonesia historical price database.

The daily data cover the periods from 2 January 2002 to 29 June 2007, this is taken to eliminate the bias possibility in crisis period. Because the day trading between the stock market and foreign exchange market is not common a matching process is necessary to be done to make the data have a homogenous time frame. The final data both for the stock market and foreign exchange market consist of 1335 observations for both of the market.

To analyze the volatility spillover effect, all of the time series data from each market are converted into compounded rate of return. The final return series data are consisted of 1334 observations both for the stock returns and foreign exchange return (USD, GBP, JPY, and EUR).

Before analyzing the volatility spillover effect analyzing the characteristic of the time series data are required. This is done to understand the data character and choosing the most suitable analytical model that fit with the data character. The summary statistics of the variables used in this study are presented in table 1 for exchange rates and IHSG data, while table 2 and 3 explains the sectors stock indices data.

Table 1. Summary statistic of IHSG and Exchange Rate Data

	EUR	JPY	GBP	USD	IHSG
Observations	1334	1334	1334	1334	1334
Mean	-0.0001365	-5.28E-05	0.000242	-0.0001091	0.001289
Median	-0.0001936	-9.61E-05	0.000109	-0.0001092	0.001805
Maximum	0.05401	0.03193	0.0946	0.03726	0.05323
Minimum	-0.04944	-0.05317	-0.1218	-0.05324	-0.1093
Std. Dev	0.007097	0.006646	0.008285	0.005435	0.01308
Skewness	-1.2949	-0.203	0.2779	-0.2773	-0.8366
Kurtosis	51.4504	8.2657	10.8144	16.0424	9.1066
Jarque-Bera	130851.411	1550.354	3411.358	9472.054712	2228.345
ADF test*	-44.502	-36.6942	-39.4503	-36.892	-32.0546

Table 2. Summary statistic of the sector data

	agriculture	basic	consumer	Finance	infra
Observations	1334	1334	1334	1334	1334
Mean	0.00200	0.00120	9.14820	0.00130	0.00150
Median	0.00074	0.00058	0.00061	0.00100	0.00110
Maximum	0.13410	0.05310	0.08510	0.06950	0.11010
Minimum	-0.10580	-0.09780	-0.10480	-0.08470	-0.18600
Std. Dev	0.02280	0.01540	0.01320	0.01630	0.02040
Skewness	0.34720	-0.65850	-0.00410	-0.12860	-0.44220
Kurtosis	5.76800	7.41480	9.60460	5.59070	10.01330
Jarque-Bera	453	1180	2425	377	2777
ADF test	-34.49450	-32.52730	-34.00450	-32.67680	-34.74700
	manufacture	mining	Misc.	Property	trade
Observations	1334	1334	1334	1334	1334
Mean	0.00100	0.00200	0.00110	0.00160	9.57200
Median	0.00084	0.00170	0.00093	0.00082	0.00064
Maximum	0.04750	0.11840	0.06310	0.09470	0.05820
Minimum	-0.09250	-0.11790	-0.08020	-0.13560	-0.10290
Std. Dev	0.01240	0.02020	0.01730	0.01750	0.01300
Skewness	-0.56170	0.07800	-0.15950	-0.21010	-0.68200
Kurtosis	7.65050	7.00380	4.23960	9.21480	8.58880
Jarque-Bera	1272	892	91	2157	1840
ADF test	-32.88810	-32.63450	-34.37870	-32.19450	-35.85340

All of the return time series data variables are showing a tendency of non normality. The entire variables are showing a high kurtosis and skewness level, exceeding the normal (Gaussian) distribution. More over the Jarque-Bera test of normality also showing a high result, especially for the return level of the data, greater than the result for normal distribution. Therefore null hypothesis of normal distribution is rejected in the case.

To check the stationary and the order of integration of the return series data, I used Augmented Dickey Fuller test. The result showing negative ADF test value thus null hypothesis of unit root is strongly rejected both for the stock return and foreign exchange return. It is concluded that the return series data are stationary and integrated of order 1. (See table 1; 2; and 3)

The first degree of correlation in the return series must be eliminated to make the data can be further analyzed. The residual is used for further test of auto correlation and ARCH effect existence. So fitting the return series data to the AR(1) model is necessary.

The residual data from the model also will be used later on for introducing the shock emanating process in one market to the volatility equation of the other market.

Table 3. AR(1) model fitted to data [2]

	AR(1)	Constant	LjungBox Q Resd		LjungBox Q2 (Resd^2)		Engle's ARCH test	
			Stat Value	Critical Value	Stat Value	Critical Value	Stat Value	Critical Value
EUR	-0.05635	0.0001894	30.0249	31.4104	261.255	31.4104	250.0204	3.8415
JPY	1.92E-02	-8.57E-05	10.5083	31.4104	120.854	31.4104	98.7997	3.8415
GBP	0.015275	-0.00015	29.0542	31.4104	222.9172	31.4104	216.2794	3.8415
USD	-0.01900	-0.000007	24.3589	31.4104	232.2326	31.4104	175.326	3.8415
IHSG	0.11989	0.001305	28.6412	31.4104	106.1986	31.4104	10.3748	3.8415

Table 4. AR (1) model fitted to sector data

	AR(1)	Constant	LjungBox Q (Resd)		LjungBox Q2 (Resd^2)		Engle's ARCH test	
			Stat Value	Critical Value	Stat Value	Critical Value	Stat Value	Critical Value
agriculture	0.023708	0.001088	19.0197	31.4104	124.0366	31.4104	19.7747	3.8415
basic	0.084082	0.001142	20.8067	31.4104	155.2141	31.4104	23.8819	3.8415
consumer	0.048698	0.000649	17.618	31.4104	37.2667	31.4104	6.3209	3.8415
finance	0.072122	0.001030	27.749	31.4104	175.7157	31.4104	17.0219	3.8415
infra	0.037712	0.001364	29.7499	31.4104	144.0754	31.4104	29.4417	3.8415
manufacture	0.9231	0.21127	10.0762	31.4104	39.9878	31.4104	7.2371	3.8415
mining	0.089199	0.001701	28.4619	31.4104	127.1824	31.4104	17.2623	3.8415
Misc.	0.0630 17	0.0011 53	31.05 2	31.41 04	89.46 59	31.41 04	17.37 08	3.8415
property	0.0882 6	0.0009 23	31.07 19	31.41 04	403.2 979	31.41 04	20.82 82	3.8415
trade	- 0.0069 63	0.0011 31	17.97 43	31.41 04	84.16 95	31.41 04	21.09 59	3.8415

Ljung Box Q2 test is used to test the autocorrelation on the residual data and squared residual data. The null hypothesis of "no autocorrelation" is not rejected for the residual data (all stat value is below the critical value to reject the null hypothesis), however the autocorrelation exist on the squared residual data (stat value is excess the critical value to reject the null hypothesis). This is showing that the GARCH must be used to further analysis the volatility. See table 4, 5, and 6.

In order to confirm the existence of ARCH effect Engle's ARCH test function is used. The result of the test showing that the ARCH effect existence (null hypothesis of "no ARCH effect" is rejected because the stat value is far above the critical value) and this is supporting the fact that the use of GARCH modeling is appropriate to analyze the entire market.

2) All critical value is in 85% confidence level

5. Volatility and Spillover Analysis

Finally because all of the character of the data lead us to apply ARCH class model, the data is fitted to AR (1) EGARCH (1,1) to examine the volatility spillover effect. The model used another market residual (i.e. exchange rate) as a shock spilling over to the market (i.e. stock market) that is currently being examined.

EGARCH (1,1) for stock market:

$$\ln h_t(stock) = \omega_0 + \beta_1 \ln h_{t-1} + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \phi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \psi\,(resid_{erate})$$

EGARCH (1,1) for exchange rate:

$$\ln h_t(erate) = \omega_0 + \beta_1 \ln h_{t-1} + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \phi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \psi\,(resid_{stock})$$

With the maximum likelihood method we can find the coefficient value and t-statistic value of each variable in the model including the volatility spillover coefficient. The coefficient value of volatility spillover explains the explanatory model of shock effect from one market to the examined market. while the t-statistic value explains the significance of the variable to the overall model. In this research 95% confidence level, so the t-statistic below -1.96 and above 1.96 indicates that the variable has significant explanatory power.[3]

The result of the examination of volatility spillover effect of each currency movement to IHSG is that only USD/IDR and JPY/IDR fluctuation significantly affecting the IHSG volatility at 95% confidence level. GBP/IDR fluctuation and EUR/IDR fluctuation appear to give insignificant volatility spillover effect to the IHSG volatility. Moreover the USD/IDR exchange rate give more explanatory power compare to JPY/IDR to the volatility of IHSG.

3) In t-stat with number of sample more than 120, we can assume that the Z-stat probability distribution is use (Levine, Krehbiel, Berenson. 2006). Due to the distributions in this equations are 2 tail distributions the z-stat is considered absolute.

Table 6. Volatility spillover summary IHSG to exchange rate

IHSG exposure to currencies				
Rank of priority	currencies*	t-statistic	significance at 5 % significant level	Regression coefficient
1	EUR/IDR	-3.6890	Significant	-0.047266
2	JPY/IDR	-3.8916	Significant	-0.045033
3	USD/IDR	-5.5860	Significant	-0.036947
4	GBP/IDR	0.011856	Non Significant	0.011856

The IHSG movement seemed also has a significant volatility spillover effect on USD/IDR, JPY/IDR, EUR/IDR currency movement on 95% confidence level. However it appears that the IHSG movement does not have significant effect on GBP/IDR movement.

Table 7. Volatility spillover summary exchange rate to sectors

Sectors Indices	Volatility Spillover Regression Coefficient of Significant Volatility Spillover on 5% significant level			Non Significant
	Rank 1	Rank 2	Rank 3	
Agriculture	JPY (-0.2110)			USD,GBP,EUR
Basic Industry	USD (-0.3688)	JPY (-0.2274)	EUR (-0.1000)	GBP
Consumer Goods	JPY (-0.1488)	USD (-0.1318)	EUR (-0.0822)	GBP
Finance	USD (-0.4846)	JPY (-0.2479)	EUR (-0.20106)	GBP
Infrastructure	USD (-0.4475)	JPY (-0.2985)	EUR (-0.2083)	GBP
Manufacture	USD(-0.2685)	JPY (-0.1824)	EUR (-0.078217)	GBP
Mining	USD (-0.4071)			JPY,EUR,GBP
Misc. Industry	USD (-0.34364)	JPY (-0.2142)		GBP,EUR
Property	USD (-0.32768)	JPY (-0.12318)	EUR(-0.088299)	GBP
Trade	USD (-0.23714)	JPY (-0.20036)	EUR (-0.11885)	GBP

In sector indices level, it appears that the USD/IDR price movement is significantly affecting the IHSG index and 9 of 10 sectors index movement in Indonesia. Agriculture sector is the only sector that lack of significant evidence of volatility spillover effect occurring from the exchange rate.

JPYIDR is also showing significant evidence of volatility spillover effect on the IHSG movement. It also affects 9 of 10 sectors in Indonesia. The volatility spillover effect is insignificant in mining sector.

EUR/IDR is not showing a significant volatility spillover effect to the overall index (IHSG); however when we go to sector level, the EUR/IDR seemed to have a volatility spillover effect to particular sectors. It affects 7 of 10 sectors in Indonesia, which are basic industry, consumer goods, finance, infrastructure, manufacture, property, and trade.

GBP/IDR in the examined time period shows a lack of significant evidence of volatility spillover effect occurrence in all sectors as well as to overall index.

If we rank the volatility spillover explanatory power of each currency we can find that most of the sector's volatility is exposed to USD/IDR fluctuation as the highest volatility spillover contributor. USD/IDR give highest volatility spillover in 8 of 10 sectors, only in 2 sectors that the volatility spillover of USD/IDR is lesser than Japan's which are in the agriculture sector and consumer goods sector. JPY/IDR are mostly giving lesser volatility spillover effect compare to USD/IDR, however the effect is much higher than the volatility spillover effect of EUR/IDR.

6. Conclusions

From the research, it is concluded that all of the financial time series variables are comes from non normal distribution, moreover the financial time series shows a heterocedasticity, therefore ARCH model is more appropriate to model the financial time series. In 95% confidence level only USD/IDR and JPY/IDR exchange rates has a significant explanatory power to the volatility of Jakarta Stock Indices. The IHSG movement also has a significant explanatory power to the volatility of EUR/IDR, JPY/IDR, and USD/IDR. This is showing that the volatility spillover between the foreign exchange market and stock market vice versa in Indonesia is significantly occurred. In sectors level, it appears that each sector has a different exchange rate volatility exposure; different sectors may have a different exchange rate volatility spillover affect that significantly affecting the sector return volatility.

References

Crouchy, G.M. (2006). *The Essential of Risk Management*, McGraw-Hill.

Dowd, K. (2005). *Measuring Market Risk*, Second Edition, John Wiley.

Francis, B.B., Hasan, I. and Hunter, D.M. (2006). "Dynamic Relations between International Equity and Currency Markets: The Role of Currency Order Flow", *Journal of Business*, Vol. 79, No. 1, 219-258.

Giddy, I.H. and Dufey, G. (n.d.). "The Management of Foreign Exchange Risk". *http://pages.stern.nyu.edu/~igiddy/fxrisk.htm*.

Greene, W.H. (1997). *Econometric Analysis*. Third Edition. Prentice Hall, New Jersey.

Harrington, N. (2003). *Risk Management & Insurance*. Second Edition, McGraw-Hill.

Jarque, C.M. (1980). "Efficient tests for normality, homoscedasticity and serial independence of regression residuals", *Economics Letters*, Vol. 6, No. 3, 255-259.

"Kurs Uang Kertas Asing", Diunduh dari *www.bi.go.id/web/id/Moneter/ Kurs+Bank+Indonesia/ Kurs+Uang+Kertas+Asing/*

LeSage, J.P. (1999). "Applied Econometrics using MATLAB", Diunduh dari *http://www.spatial-econometrics.com/html/mbook.pdf*.

Levine, D.M., Krehbiel, T.C. and Berenson, M.L. (2006). *Business Statistics*: A first Course. Fifth Edition, Pearson Prentice-Hall Education.

Ljung, G.M and Box, G.E.P. (1978). "On a Measure of a Lack of Fit in Time Series Models", *Biometrika*, Vol. 65, No. 2, 297-303.

lanurung, A.H. (2005). "Statistika Dalam Dunia Investasi", Diunduh dari *http://finansialbisnis.com/Data2/Riset/Statistik-Investasi.pdf.*

lishra, A.K, Swain, N. and Malhotra, D.K. (2007)."Volatility Spillover between Stock and ForeignExchange Markets: Indian Evidence", *International Journal of Business*, Vol. 12, No. 3.

arulita,W.A. dan Titi, M. (2006). "Measurement On First-Moment Exchange Rate Exposure And Second-Moment Sector Index Exposure (Evidences from Jakarta Stock Exchange)". Diunduh dari *http://www.fiskal.depkeu.go.id/webbkf/ kajian%5CEXCHANGE.pdf.*

:ayyum, A. and Kemal, A. R. (2006). "Volatility Spillover Between the Stock Market and the Foreign Exchange Market in Pakistan", *PIDE Working Papers* 7, 1-16.

udarmanto, R.G. (2005). *Analisis Regresi Linear Ganda dengan SPSS*. Graha Ilmu: Yogyakarta

urya, Y. (2003). Ekonomifisika dan Nobel Ekonomi. Diunduh dari *http://www.yohanessurya.com/download/Ekonofisika_04_NobelEkonomi.pdf.*

urya, Y. dan Hariadi, Y. (2003). *"Kulminasi Prediksi Data Deret Waktu Keuangan Volatilita dalam GARCH(1,1)"*, Working Paper WPF 2003.