(2009) *International Journal of Global Management Studies Professional* vol. 1, iss. 3.

A GARCH Analysis of Volatility in Country Indices

Matthew D. Brigida*

Department of Finance, Clarion University of Pennsylvania

Abstract

This paper estimates the coefficients of the Heston-Nandi GARCH(1,1) model of the distribution of log-returns, for each country with an MSCI index as of 1996. These parameters are compared across developing and developed nations. I also test whether these parameters are affected by the level of governance in each country. I find that total risk, adjusted for kurtosis, is a significant predictor of whether the country is developed or developing. Further, I find that relative total volatility, between developed and developing nations, varies over time. Further, there is no constant relationship between governance indicators and the skewness or kurtosis of log-returns in the country indices. These results imply that financial analyses which rely on the distribution of returns, particularly derivative pricing and value-at-risk, may be implemented in the same fashion across developed and developing markets so long as the analyses account for differing first and second moments.

Keywords: Risk Management; Stochastic Volatility

* 840 Wood St., Still Hall 318, Clarion PA 16214
email: mbrigida@clarion.edu

A GARCH Analysis of Volatility in Country Indices

I. Introduction

The goal of this article is to relate the moments of the distribution of a country's market index log-returns to measures of that country's governance quality, and level of overall development. To this end I make use of the Heston-Nandi GARCH(1,1) model to estimate coefficients which describe the distribution of an asset's log-returns. The GARCH model was derived in Heston and Nandi [5].

This GARCH model affords the first four moments of the return distribution while controlling for temporal dependence between returns. Controlling for such dependence is particularly important in less efficient developing world equity markets.

This article contributes to the literature on how a country's governance quality affects financial markets and the behavior of participants in those markets. Moreover, since I am considering each country's volatility (risk), this analysis begins to quantify the cost of poor governance.

Recently, Morck, Yeung, and Yu [8] found economies with stronger public investor property rights exhibit greater firm specific variances. Gibson [3] found corporate governance is ineffective in emerging markets, which highlights structural differences among countries which may affect stock return characteristics. Klapper and Love [6] found the strength of a country's legal environment is related to firm-level corporate governance and asymmetric information. These results motivate interest in the effect of country governance quality on the parameters of the distribution of stock index returns.

Evidence of time varying volatility in emerging markets was found in De Santis and Imrohoroglu [2]. Further, their results found evidence that kurtosis may be larger in the returns emerging markets. However, they only included a sample of 4 developed markets in their analysis which precluded formal statistical tests of differing kurtosis (and other moments) of the return distribution among emerging and developed market indices. In addition to improving on the volatility estimates, this paper builds on these earlier results by including a larger sample of developed market indices to allow statistical inference. Further, this analysis relates measures of governance quality to the moments of each country's market index return distribution thereby going beyond very broad 'developed' and 'developing' market classifications.

Hypothesis

Foremost, we should expect developing nations to have higher total risk. Beyond a higher overall volatility, we would further expect the distribution of returns in developing countries to exhibit more kurtosis. Because developing countries tend to have lower scores in governance measures, it follows that low governance scores should accompany greater kurtosis.

Possible differences in the asymmetry of the log-return distribution (skewness) between developing and developed nations are debatable, and therefore on this point my analysis will take a more investigatory stance. With regards to the persistence of volatility, however, I should expect less developed markets to have more persistent volatility.

Application

In this paper I investigate the mean, variance, and higher moments of the distribution of log-returns of country indices. The ability to correlate attributes of a country, such as level of development or governance, with the behavior of these characteristics of the log-return distribution of that country's index has important implications to risk management and derivative pricing. Specifically, we may consider Value-at-Risk (VaR), and option pricing.

1. VaR

In VaR we are interested in finding the smallest number x such that the probability that the next days loss on our index (or portfolio) will be greater than x is, say, not greater than 1%. By letting L be the next day's loss, we may denote this as:

$$P[L \geq x] \leq 0.01$$

In implementing VaR, one must decide which distribution to use to model the portfolio's return, or if recourse should be made to non-parametric methods. Commonly, a normal distribution is used.

For example, one of the most widely used VaR methodologies was developed by RiskMetrics^{TM} when it was a subsidiary of J.P. Morgan. In this VaR calculation the log returns follow an IGARCH(1,1) process with a normally distributed conditional distribution. This method allows for stochastic volatility, though assumes the normal distribution for returns. For a full review of the methodology see Longerstaey and More [7].

If a normal distribution is assumed when the actual distribution exhibits kurtosis, then the x found in the VaR calculation will understate the actual x. In other words, the likelihood of large losses is understated, and therefore the portfolio will have more risk that the VaR shows.

So, to implement (parametric) VaR, it is important to understand the higher moment of the distribution of log-returns. In this paper I investigate whether there is a significant difference in kurtosis between developed and developing nations with a logit model. I further test whether governance indicators are a good predictor of kurtosis. If kurtosis is present, there would be a strong argument to use a nonparametric, historical VaR.

2. Option Pricing

The option pricing model derived in Black and Scholes [1] assumes stock prices follow a geometric Brownian motion. Therefore stock prices are lognormally distributed and log returns are normally distributed. This option pricing model is widely used by both retail and institutional investors.

The more the log-returns of an asset deviate from the normal distribution with a constant variance, the less applicable is the Black-Scholes model of the price of an option on that asset. The analysis which follows investigates whether developing nations exhibit greater deviation in the higher moments of their log-return distribution than do developed nations. If so, the Black-Scholes model would be less applicable with respect to options on developing market indices, and this would support the necessity of using stochastic volatility or nonparametric models in these markets.

II. Data and Methodology

Data

The sample of countries used in this analysis consists of all countries for which there was a MSCI country index for the years 1996 and thereafter. This is a sample of 47 countries. For each country I downloaded the MSCI country price index in local currency, with a weekly frequency. I downloaded the time series for the years 1996 through 2006. I next converted the weekly prices into a time series of log returns.

For each of these countries I obtained measures of voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption from the World Bank's Aggregate Governance Indicators Dataset 1996-2004. These data are available for the even years starting with 1996 and ending with 2004. I also obtained each country's lending interest rate for each even year 1996 – 2004 from the World Bank's Development Dataset. Lastly, I found a classification for each country as either developed or developing.

Volatility Analysis

In this paper I am interested in the characteristics of the distribution of returns of each country's index as measured by the coefficients of the Heston-Nandi GARCH(1,1) model. The Heston-Nandi GARCH(1,1) model assumes that the log-spot price of the asset follows the following GARCH process over time intervals of length Δ:

$$\log(S(t)) = \log(S(t-\Delta)) + r + \lambda h(t) + \sqrt{h(t)}\, z(t) \tag{1a}$$

where

$$h(t) = \omega + \beta h(t-\Delta) + \alpha \left(z(t-\Delta) - \gamma \sqrt{h(t-\Delta)} \right)^2 \tag{1b}$$

where r is the continuously compounded interest rate over the interval Δ, and z(t) is a standard normally distributed random variable. The conditional variance of the log-return between t-Δ and t is h(t), and h(t) is measurable with respect to the information set at time t-Δ. Note that S(t) includes dividends.

In the mean equation (1a), the term λh(t) may be interpreted as the risk premium. Note, that the expected spot return on the asset is a linear function of the conditional variance h(t) (as λ is a constant). Further, if the conditional variance h(t) is zero, then the asset earns the risk-free rate r. Also, note that as both α and β approach zero, this model approaches the Black-Scholes model of the spot price, observed at discrete intervals (as the conditional variance is a constant ω). The model is stationary if $\beta + \alpha\gamma^2 < 1$.

We may rearrange (1a) and (1b) to solve for the conditional variance at time t+Δ, h(t+Δ), given variables observed at time t and earlier as:

$$h(t+\Delta) = \omega + \beta h(t) + \alpha \left(\frac{\left(\log(S(t)) - \log(S(t-\Delta)) - r - \lambda h(t) - \gamma h(t)\right)^2}{h(t)} \right) \qquad (2)$$

Above, α measures the kurtosis of the distribution of log returns. As α → 0, h(t+Δ) approaches a non-random variance which is a function of time. The coefficient γ measures the asymmetric relationship which the shock term, z(t), has with the next period's conditional variance. To wit, γ allows the model to capture that a large negative shock may affect h(t+Δ) greater than a large positive shock. This is the widely observed feature that the implied volatility in options usually increases as the market falls, and decreases as the market rises. The relationship between the spot return and the next period conditional variance can be seen in the covariance between the two:

$$Cov_{t-\Delta}\left[h(t+\Delta), \log(S(t))\right] = -2\alpha\gamma h(t) \qquad (3)$$

So, by estimating the Heston-Nandi GARCH(1,1) we will obtain estimates of the five coefficients λ, β, ω, α, γ, for each index for each year. Moreover, from the aforementioned, these coefficients will afford us measures of how: the average spot return depends on the level of risk, λ; the kurtosis (α) and skewness (γ) of the distribution of log returns; as well as the mean and variance of the log returns.

Of particular interest across countries are the signs of α and γ. If both are positive, then we can see from (3) that spot returns and the next period conditional variance are negatively correlated.

Similar to the standard GARCH(1,1) model, the estimation of (1b) also allows the calculation of the persistence of volatility (the degree of autoregressive decay in the squared residuals). This is possible as in a GARCH(1,1) model the errors are uncorrelated, however the squared errors are correlated. For the Heston-Nandi GARCH(1,1) model, volatility persistence may be measured as (using the estimated coefficients from (1b)):

$$\beta + \alpha \quad - \quad \gamma + \tag{4}$$

Next, I ran a standard GARCH(1,1) model of the form:

$$y_t = \quad + \tag{5a}$$

$$\varepsilon = \nu \sqrt{\kappa + \varphi\varepsilon \quad + \eta \quad _{t-}} \tag{5b}$$

where ξ, κ, φ, η, are estimated coefficients, h_t is the conditional variance of ε_t, and ν_t is a white noise process. Note that the persistence of volatility is measured as (φ+η) in (5b). From (5b) I also calculate the long-term volatility:

$$\sqrt{\frac{\kappa}{1- \quad - \quad}} \tag{6}$$

Lastly, I calculated the standard deviation of weekly returns for each asset, in order to ascertain if the GARCH models afford any information beyond that conveyed by the total risk of the index.

Therefore, the data set used in this analysis consists of, for each country and for each even year ranging from 1996-2004, the six measures from the World Bank Aggregate Governance Indicators Dataset; the five coefficients estimated with the Heston-Nandi GARCH(1,1) model as well as the volatility persistence from (4); the three coefficients from the standard GARCH(1,1) model as well as the long-term volatility; the standard deviation; and whether the country is developed or developing.

Logit Analysis

To investigate whether the moments of the distribution of log-spot prices (the coefficients in the Heston-Nandi GARCH(1,1) model), are good predictors of whether the market index is in a developed or developing country, I will run a logistic regression. In this regression the dependent variable will be 0 for developing countries and 1 for developed countries. I will run 5 logistic regressions, one for each even year 1996-2004 inclusive.

The independent variables are λ, α, γ, and persistence from the Heston-Nandi GARCH(1,1) model; and the orthogonalized total risk of the market index measured as the orthogonalized standard deviation. I orthogonalize the standard deviation with respect to alpha (α), as the standard deviation is the square root of the second moment of the distribution of log returns while alpha (which measures the kurtosis of the distribution) is the fourth moment.

This means that the larger the kurtosis (which measures the fatness of the tails of the distribution), the larger will be the standard deviation. I am interested in the standard deviation in excess of that caused by the kurtosis in the distribution. Therefore, to orthogonalize the standard deviation, I run a simple OLS regression with standard deviation as the dependent variable and alpha (kurtosis) as the independent variable. In the logistic regression I include the residuals of this regression to measure this excess standard deviation.

Note, the standard deviation acts as a control. Since developing market indices tend to have a higher standard deviation, we need to control for the parameters of the GARCH model that are affected by the higher standard deviation.

Multivariate OLS Analysis

To investigate whether a country's governance measures affect the characteristics of the volatility in that country, I will run a series of multivariate OLS regressions. The dependent variables will be, from the Heston-Nandi GARCH(1,1) model, λ, α, γ, and persistence. For each of these dependent variables I will run a regression for each even year 1996-2004 inclusive.

The independent variables in these regressions will be indices for a country's control of corruption, government effectiveness, political stability, rule of law, regulatory quality, voice and accountability. Standard deviation is not included as an independent variable as it is, as aforementioned, the square root of the second moment of the distribution of log returns, while the dependent variable kurtosis is the fourth moment of the distribution. It would be to no avail to orthogonalize standard deviation and then include the excess standard deviation in an OLS regression with kurtosis as the dependent variable, as the orthogonalization process would cause the coefficient of the excess standard deviation to be zero.

Total volatility, and the characteristics of that volatility, changes significantly from year to year, however, governance indicators generally change very little. For this reason I am using a separate regression for each year, and not a panel data regression.

III. Results

Univariate Results

Table 1 contains the mean value of each governance quality indicator conditioned on whether the country is developed or developing, as well as a t-test for the difference in these means. Each governance indicator is significantly greater for the set of developing countries than for the developing countries. For each indicator this difference is significant at less than the 0.1% level.

Table 1
Univariate Results

Below are t-tests for differences in mean values for the five governance indicators. The t-test compares mean values conditioning on whether the market index is in a developed or developing market. The governance indicators are from the World Bank's Aggregate Governance Indicators dataset for 1996-2004. The indicators voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. ****, ***, **, * denotes significance at the 0.1%, 1%, 5%, and 10% respectively.

	Mean if Developed	Mean if Developing	Difference	T-stat	P-value
Voice and Accountability	1.24	-0.05	1.29	17.2	<2e-16****
Political Stability	1.04	-0.25	1.29	14.2	<2e-16****
Government Effectiveness	1.7	0.1	1.6	21.2	<2e-16****
Regulatory Quality	1.35	0.23	1.12	15.9	<2e-16****
Rule of Law	1.6	-0.005	1.605	22.3	<2e-16****
Control of Corruption	1.7	-0.1	1.8	24.6	<2e-16****

Table 2 below contains the differences in mean values for the five coefficient estimates from the Heston-Nandi GARCH(1,1) model of the distribution of log-returns, and the persistence of volatility, conditioned on whether the market index is in a developed or developing country. T-tests for differences in means follow.

Volatility's effect on log-returns (measures by the coefficient λ) is significantly greater for developed compared with developing markets. This implies a more well defined risk-return relationship in established markets.

Consistent with the hypothesis, the kurtosis of the return distribution is significantly greater in developing markets as compared with developed markets. This is evidence that there are differences in the higher moments of the return distribution between developed and developing markets. Note, these higher moments are not captured in standard option pricing and risk management models.

Both the mean return and standard deviation of returns are significantly greater for developing as compared with developed markets. This is consistent with higher total asset risk implying a greater required return. Unlike the higher moments of the return distribution however, these differences are captured in standard option pricing and risk management models.

Table 2
Univariate Results

Below are t-tests for differences in mean values for the five coefficient estimates from the Heston-Nandi GARCH(1,1) model of the distribution of log-returns, and the persistence of volatility. The t-test compares mean values conditioning on whether the market index is in a developed or developing market. The coefficients measure the effect of volatility on the spot return (λ), kurtosis (α), skewness (γ), standard deviation (σ), and the mean return (ω). ****, ***, **, * denotes significance at the 0.1%, 1%, 5%, and 10% respectively.

	Mean if Developed	Mean if Developing	Difference	T-stat	P-value
Volatility's effect on returns (λ)	3.33	0.72	2.61	2.34	0.02**
kurtosis (α)	0.00013	0.00025	-0.00012	-2.08	0.04**
skewness (γ)	51.25	9.91	41.34	1.37	0.17
standard deviation (σ)	2.89%	4.14%	1.25%	-5.6	<6e-8****
Mean return (ω)	0.05%	0.1%	-0.05%	-3.12	0.002***
Persistence	0.37	0.36	0.01	0.06	0.95

Logit Analysis Results

The results from the 5 logistic regressions may be found in Table I. One of the most notable results of the logistic regressions is that, generally, the best predictor of whether a market is in a developed or developing market is the index's total risk as measured by its orthogonalized standard deviation. The sign of the coefficient is as we would expect as I coded a developed market as 1 and a developing market as 0. In every year, besides 2002 when excess standard deviation is insignificant, the coefficient of excess standard deviation is negative. This implies the larger the excess standard deviation, the higher the probability the market index is located in a developing country.

The skewness (gamma) was only significant at the 10% level in 2004. Though, in 2004 gamma had a positive coefficient, and remembering the covariance of $t(t+\Delta)$ and $\log(S(t))$ is $-2\alpha\gamma h(t)$, we can see that in 2004 the inverse relationship between spot return and subsequent volatility is more associated with developed than developing nations' indices.

Persistence was negative and significant in 2004 at the 5% level. The negative coefficient implies the more persistent the volatility, the more likely the index is in a developing nation.

Lambda is significant in 1998, 2000, and 2002, though it changes sign being positive in 1998 and 2000 while negative in 2002. This brings up another salient point in the logit model results; namely that the way in which the parameters of the log returns' distribution relate to the level of development of the home market change over time. The parameters of a country index's volatility seem mutable.

Table 3
Logit Analysis

The dependent variable is 0 for a developing market and 1 for a developed market. Pr(> |z|) is given in parenthesis below the coefficients. ****, ***, **, * denotes significance at the 0.1%, 1%, 5%, and 10% respectively. AIC denotes Akaike's Information Criterion which is a model selection criterion that imposes a larger penalty on overparameterization than does adjusted R^2. See Greene [4] for more about AIC.

	1996	1998	2000	2002	2004
Intercept	-0.4519	-0.006675	0.8826	-1.501~	0.7946
	(0.4731)	(0.9228)	(0.16627)	(0.05921)	(0.48213)
Lambda	0.01022	0.4419**	0.3013**	-0.4075***	-0.09539
	(0.7860)	(0.0150)	(0.02547)	(0.00274)	(0.30207)
Alpha	-8955	-862.3	-1018	1102	-2397
	(0.1474)	(0.2284)	(0.19996)	(0.38664)	(0.51742)
Gamma	0.001642	0.001176	0.0009155	0.002915	0.03447*
	(0.5974)	(0.9271)	(0.77954)	(0.61062)	(0.05640)
Persistence	1.265	0.8854	0.7211	0.2392	-3.204**
	(0.3267)	(0.4705)	(0.65138)	(0.85381)	(0.04309)
Orthogonalized	-211.4**	-49.97*	-109.8***	19.04	-394.1***
St. Dev.	(0.0105)	(0.0688)	(0.00976)	(0.52602)	(0.00208)
AIC	52.237	53.332	59.155	57.612	44.22

Multivariate OLS Regression Results

Of the multivariate OLS regressions run, the most significant results are regarding kurtosis (alpha (α)) as the dependent variable, and the results are listed in Table II. Note, higher governance indicator values relate to better governance outcomes.

There are three governance measures which at some point exhibit a significant relationship with the kurtosis in the distribution of log spot returns (the fatness of the tails). These are political stability, rule of law, and regulatory quality. Of the six instances where a coefficient is significant, four coefficients have the expected sign. We would expect these three variables to be negatively related to the fatness of the tails in the return distribution. These two out of the six instances are more evidence for the constantly changing nature of volatility.

More often than not, it seems, increases in such measures as regulatory quality decrease kurtosis, though in some states of the world the correlation reverses and the more regulatory quality the more kurtosis.

Table 4
Multivariate OLS Results

The dependent variable is the kurtosis of the distribution of log-returns for each country's index, as measured by the Heston-Nandi GARCH(1,1) model. The governance indicators are from the World Bank's Aggregate Governance Indicators dataset. Estimated coefficients are above and p-values below in parentheses. ****, ***, **, * denotes significance at the 0.1%, 1%, 5%, and 10% respectively.

	1996	1998	2000	2002	2004
Intercept	0.0001519**	0.0004858**	3.321e-04***	3.4e-04****	1.2e-04****
	(0.0272)	(0.0216)	(0.00666)	(0.000374)	(6e-05)
Control of Corruption	0.00002391	0.000393	9.595e-05	3.088e-04	1.319e-04
	(0.8526)	(0.3019)	(0.72610)	(0.232088)	(0.1220)
Government Effectiveness	0.00005946	-0.0006015	1.416e-04	-1.445e-04	-1.192e-04
	(0.7259)	(0.1030)	(0.67125)	(0.531152)	(0.1397)
Political Stability	0.00002205	0.000201	-3.937e-04**	1.046e-04	9.188e-05**
	(0.7612)	(0.3778)	(0.02817)	(0.252802)	(0.0381)
Rule of Law	-0.0002517	-0.0007282*	3.268e-04	-1.068e-04	-8.907e-05
	(0.1562)	(0.0925)	(0.34339)	(0.657218)	(0.4034)
Regulatory Quality	0.00002223	0.0008085**	-4.455e-04**	-4.346e-04*	-2.127e-05
	(0.8541)	(0.0243)	(0.04973)	(0.058952)	(0.7105)
Voice and Accountability	0.0000728	0.00001558	-4.028e-05	1.791e-04	-3.494e-05
	(0.3445)	(0.9279)	(0.76786)	(0.110473)	(0.3117)
Adj. R^2	0.01864	0.2238	0.1081	0.04121	0.08357
F-statistic	1.142	3.162	1.909	1.322	1.699
	(0.3565)	(0.01266)**	(0.1037)	(0.2704)	(0.1464)

Similar results are found in the other OLS regressions, though with less significance.

IV. Implications

Prominent among the implications of this study is that the most significant, and most consistent, measure segmenting developed from developing markets is total risk, adjusted for the risk induced by kurtosis, as measured as the excess standard deviation. This measure was significant, with the expected sign, in four out of the five years estimated with the logistic model. Though, this leads into the second salient implication.

While standard deviation is the best predictor of the development of a market, even this measure loses both the desired sign and significance in one of the five years. The departure from the expected relationship may be fleeting, but it highlights that any relationship between sets of countries and their relative risk is mutable, likely striking discordant notes in times of economic turbulence.

The persistence, skewness, and kurtosis of volatility are on the whole poor predictors of whether a country is developed or developing. However, they do become significant in one of the five years, reinforcing the second implication.

From the multivariate OLS regression, we find four of the six instances of significance have the expected sign, which supports the hypothesis that better governance leads to less kurtosis in the log-return distribution. This implies that the governance measures have at best passing effect on the third and above moments of the log-return distribution.

In aggregate, this paper is evidence for the portability of financial practices across borders. Specifically, the similarity of the higher moments of the log-return distributions of developing and developed market indices is evidence for the use of the same VaR and option pricing methods across these markets. The significant difference between developed and developing markets is in their respective standard deviations, and VaR and the Black-Scholes model both account for differing standard deviations.

V. Conclusion

In this article I have found evidence supporting that developed countries have relatively less risk than developing countries, even when you adjust for the effect of kurtosis on the total risk. That is to say, the increased standard deviation in developing market's indices is not solely located in the tails, but rather there is a significant difference in the excess standard deviations alone.

Moments in the distribution of log-returns higher than the variance seem to be affected little by governance quality, and therefore are not good predictors of the development of a country's market. More work can be done in this regard, though, particularly as more data becomes available with respect to governance.

Lastly, the relative level of risk, between developing and developed markets, has shown evidence of changing over time. Moreover, the moments of the distribution above the variance do become significant within the sample period. Likewise, while usually insignificant, governance measures do become significant in particular years. More work can be done to correlate the timing of the significance with macroeconomic events.

The aforementioned would clearly be important for derivative pricing and VaR. It would be worthwhile to know for such endeavors, in what states of the world, the assumptions about relative volatility, the asymmetry of returns, and the fatness of the tails of the return distribution become invalid.

References

[1] Black, F. and M. Scholes, 1973, "The pricing of options and corporate liabilities", *Journal of Political Economy* 81, 637-659.

[2] De Santis, G. and S. Imrohoroglu, 1997, "Stock returns and volatility in emerging financial markets", *Journal of International Money and Finance* 16, 561.

[3] Gibson, M., 2003, "Is corporate governance ineffective in emerging markets?", *Journal of Financial and Quantitative Analysis* 38, 231-250.

[4] Greene, W.H., 2003, *Econometric Analysis,* (5th ed.), Prentice-Hall, New Jersey.

[5] Heston, S., and S. Nandi, 2000, "A closed-form GARCH option valuation model", *Review of Financial Studies*, 13, 585-625.

[6] Klapper, L. and I. Love, 2004, "Corporate governance, investor protection, and performance in emerging markets", *Journal of Corporate Finance* 10, 703-728.

[7] Longerstaey, J. and L. More, 1995, *Introduction to RiskMetrics™*, 4th edition, Morgan Guaranty Trust Company, New York.

[8] Morck, R., B. Yeung, and W. Yu, 2000, "The information content of stock markets: why do emerging markets have synchronous stock price movements?", *Journal of Financial Economics* 58, 215-260.