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COVID19 Outbreak Impact on International Stock Markets Volatility Contagion

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ABSTRACT

We analyze volatility contagion between the U.S. and Chinese stock markets and international capital markets. The volatility is modeled using: GARCH, TARCH, EGARCH, APARCH, IGARCH, FIGARCH, ACGARCH and GAS models under Gaussian, GED and t-Student distributions. 21,000 intraday observations of thirteen markets from January/1st to June/25th 2020 are employed. Once volatility is modeled, the incidence of Chinese and American markets on the rest of the bourses is tested employing Vector Autoregressive Markov Switching Models. Evidence confirms incidence of the Chinese and American capital markets volatility in other markets volatility; common breakpoints and Intermarket incidence in high volatility periods stand out.

Keywords: volatility contagion; Markov Switching Model; Garch Approach; Stock Markets; Covid 19.
JEL classification: G01, G15, F36, C57, C58.
MSC2010: 60JXX, 62HXX, 62P20, 39B55.

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Impacto del estallido de COVID19 en la volatilidad de los mercados de capital internacionales

RESUMEN

El objetivo de este trabajo es analizar el contagio de volatilidad entre los mercados de valores estadounidense y chino y los mercados de capitales internacionales. Para lograr este propósito, la volatilidad se modela utilizando varios enfoques simétricos y asimétricos: GARCH, TARCH, EGARCH, APARCH, IGARCH, FIGARCH, ACGARCH y GAS bajo tres supuestos de distribución: Gaussiana, GED y t-Student. Se emplean 21.000 observaciones intradía de trece índices bursátiles para el periodo comprendido entre el 1 de enero de 2020 y el 25 de junio de 2020. Una vez modelizada la volatilidad, se comprueba la incidencia de los mercados chino y americano sobre el resto de mercados bursátiles empleando modelos MS-VAR.

Palabras clave: contagio en volatilidad; Modelo de cambio de régimen Markoviano; modelos GARCH; mercados Accionarios; Covid 19.
Clasificación JEL: G01, G15, F36, C57, C58.
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1. Introduction

Since its inception, the ongoing pandemic situation had an enormous social, economic, and financial impact all over the world. The COVID 19 crisis has had a local and international impacts: sharp unemployment increments, large contraction of industrial activity, tourism practically paralyzed, and international trade and investment weakened; all these economic effects contracted sharply global demand, affecting enterprises' productivity and output, as well as financial corporations returns.

Bad news, increasing uncertainty, negative expectations, and lower corporate profits generated widespread stock market crashing, in Paris and Frankfurt about 12% and London FTSE 11%, outstripping the depth of the Eurozone debt crisis. In March 2020, the Dow Jones had its worst day since 1987 (12.9%) and S&P 500 dropped 20% from a prior high (Lynch et al., 2020). The price of a barrel of oil collapsed by more than $30 in the worst trading day since 1930 (Sheppar, Raval & Lockett, 2020).

In other financial markets, investors bought government bonds from UK, US and Germany considered as safe havens with low to negative interest rates. Currency markets suffered important depreciations, above all in emerging markets (The FRED® Blog, 2020), Brazil's and Mexico's exchange rates spiked, and their currencies depreciated 46% and 30%, respectively from January to May 2020. In the derivatives market, futures were in a contango situation.

Economic and monetary authorities and multilateral organisms have developed strategies intervening in financial markets, stimulating economies, and thus creating some certainty, reducing fear and nervousness among investors. The International Monetary Fund (IMF) has provided assistance since late March for $250 billion, a quarter of its $1 trillion lending capacity (IMF, 2020). It estimated that the global fiscal support neared $9 trillion at the end of May 2020, the direct budget support was around $4.4 trillion, and additional public sector loans, and equity injections, guarantees, and other quasi-fiscal operations amounted other $4.6 trillion (Battersby, Lam & Ture, 2020).

Many studies have been advanced to deal with the financial and economic effects of COVID-19. McKibbin and Fernando (2020), Fernandes (2020), Ahmad, Haroon and Hui (2020), Dietrichel et al. (2020) examine the COVID-19 economic effects. Baldwin and Tomiura, (2020) and Vidya and Prabheesh (2020) analyze the implications of COVID-19 on trade. Apergis and Apergis (2020) investigate the impact on oil prices. Njindan (2020) and Iqbal et al. (2020) study the influence of COVID-19 pandemic on exchange rates.

Closely related with our study, Baker et al. (2020) find that government restrictions due to the COVID-19 pandemic generated a bigger effect, in the US stock market, than previous pandemics 1918-19, 1957-1958 and 1968. Al-Awadhi et al. (2020) evidence that the number of deaths and confirmed cases of COVID-19 had a negative impact on Chinese stock returns. Topcu and Gulal (2020) determines that Asian and European stock markets had the highest impact among emerging stock markets. Phan and Narayan (2020) argue that stock markets overreacted to unexpected news, when the information expanded and markets calmed down, the market corrected itself. Akhtaruzzaman, Boubaker and Sensoy (2020) found that financial firms were more contagious than nonfinancial firms and China and Japan transmitted more spillovers than they received during the COVID-19 crisis period.

Follow Bai et al. (2022), Bai et al. (2021), Goodell (2020), Liang et al. (2021, 2020), and Akhtaruzzaman et al. (2021), this study contributes expanding knowledge about the COVID19 financial effects transmission, using stock markets intraday data for thirteen economies, including developed and developing countries. The empirical approach includes volatility estimation employing GARCH and GAS models under three distributional assumptions. Once volatility is modeled, it is used to test whether Chinese and US market volatilities influenced the rest of the

markets or vice versa, through two regimes: high and low volatility; to test the two ways influence, MS-VAR model is used. Finally, MS-VAR probability results are analyzed to find common breaks and contagion periods.

The rest of the paper is structured as follows. Section 2 describes the data and methodology, section three deals with the models results and their analysis. Finally, section shows the conclusions.

2. Data and Methodology

Our data consist of 21,000 intraday observations (one-minute frequency data is employed, on average 300 prices per day) of thirteen stock market indexes over the period January 1st, 2020 to June 25th, 2020. According to Barclay and Litzenberg (1988), intraday data permit more efficient estimation of the effects of new information on stock prices. Dionne, Duchesne & Pacurar (2009) emphasize that using intraday data also allows that the risk measure has a higher informational content.

The period selection was based on immediate COVID19 financial effects. Data were collected from Bloomberg. We define the intraday log-returns $r_t = \log\left({P_t}/{P_{t-1}}\right)$ and estimate the following GARCH models.

GARCH- type models employed

GARCH $h_t^2 = \omega + \alpha u_{t-1}^2 + \beta h_{t-1}^2$

EGARCH $\log(h_t^2) = \omega + \alpha\left[\left|\frac{u_{t-1}}{h_{t-1}}\right| - \sqrt{2/\pi}\right] + \beta \log(h_{t-1}^2) + \delta \frac{u_{t-1}}{h_{t-1}}$

TARCH $h_t^2 = \omega + \alpha u_{t-1}^2 + \beta h_{t-1}^2 + \gamma u_{t-1}^2 I_{t-1}$

APARCH $h_t^\delta = \omega + \alpha(|u_{t-1}| - \gamma u_{t-1})^\delta + \beta h_{t-1}^\delta$

ACGARCH $q_t = \omega + \rho(q_{t-1} - \omega) + \theta(u_{t-1}^2 - h_{t-1}^2)$

$$h_t^2 = q_t + \alpha(u_{t-1}^2 - q_{t-1}) + \gamma(u_{t-1}^2 - q_{t-1})D_{t-1} + \beta(h_{t-1}^2 - q_{t-1})$$

FIGARCH $h_t = \omega + [1 - (1 - \beta L)^{-1}(1 - \alpha L)(1 - L)^d]\varepsilon_t^2$ where 0<d<1

IGARCH $h_t = \omega + [1 - (1 - \beta L)^{-1}(1 - \alpha L)(1 - L)^d]\varepsilon_t^2$ where d=1

Source: Based on Katsiampa (2017).

where h_t^2 is the conditional variance of u_t, and ω is a permanent component of h_t^2. All the GARCH specifications are considered with innovations distributed as follows: Normal (Gauss), t-Student, and Generalized Error Distribution (GED).

According to diverse authors (Mwaniki, 2019; Segovia, Fernández-Martínez & Sánchez-Granero, 2019; Takahashi, Chen & Tanaka-Ishii, 2019; Nikolova et al., 2020), the empirical distribution of financial series is skewed, heavy-tailed, and displays volatility clustering. Hence, we also estimate GAS models under the same three distributions.

GAS models are based on the score function of the predictive conditional density of the stock index returns at time t. Two particular advantages of GAS models are: 1) these models allow

for GARCH or Auto-regressive Conditional Duration (ACD) specifications advanced by Engle and Russell (1998), and 2) time-varying parameters re-estimation avoids the problem of using an inadequate forcing variable when the correct specification is not evident (Troster et al., 2019).

The optimal model is chosen according to Akaike (AIC) and Hannan- Quinn Information Criteria. The selected model is the one with the minimum criteria and, the higher Log-likelihood value, ensuring statistical significance (*) and positive parameters (+) (Appendix, Table A.1).

GAS Model

Let F_{t-1} be the past information set of r_t up to t-1. Let $p(r_t\ ;\ \theta_t)$ be the conditional distribution of the returns, $r_t|F_{t-1}\sim p(r_t;\theta_t)$, and let $\theta_t \in \Theta \subseteq N$ be a vector of time-varying parameters that completely identifies $p(\cdot)$. GAS model is described as follows:

$$\theta_{t-1} = \omega + \mathrm{A}s_t + B\theta_{t,} \quad [1]$$

$$s_t = S_t(\theta_t)\frac{\partial \log p(r_t;\theta_t)}{\partial \theta_t} \quad [2]$$

where $\omega, A,$ and B are coefficient matrices, s_t is vector of scaled-score steps, and $S_t(\theta_t)$ is a positive-definite scaling matrix that adjusts the shaper of the score, for instance:

$$\mathrm{S}_t(\theta_t) = E_{t-1}\left[\frac{\partial \log p(r_t;\theta_t)}{\partial \theta_t}\frac{\partial \log p(r_t;\theta_t)^t}{\partial \theta_t}\right]^{-1} \quad [3]$$

GAS approach is estimated under the same three distributions than GARCH models: Gauss, GED y t- Student.

Once, GARCH and GAS models are applied, variance series are used to model the two-ways impact of the US and China markets on the rest of the countries.

Markov Switching Vector Autoregressive

The MS-VAR developed by Krolzig (1997) is a multivariate generalization of the univariate Markov switching autoregressive model. The general concept behind this model is that the parameters of a VAR process are not static as linear approaches assume; specifically, parameters could be time-invariant whether a particular regime is maintained. However, the parameters change, if the regime does it (Pontines & Siregar, 2009).

The regime-generating process determining which regime s_t prevails at any point in time, is assumed to follow an ergodic Markov chain with a constant transition probability p_{ij} of the form

$$P_{ij} = P[S_t = j/S_{t-1}] = i \text{ with } \sum_{j=1}^{2} P_{ij} = 1 \text{ for all } i,j \in \{1,2\} \quad [4]$$

The procedure was applied to examine whether transmissions of shocks across countries intensified during the COVID19 immediate effects. Thus, we analyze the dynamic relationship between the Chinese and the US equity markets and other 13 stock markets. The MS-VAR model can be expressed as follows:

$$ch_t = \alpha_1 + \sum_{k=1}^{l}\alpha_{2j}(s_t)ch_{t-k} + \sum_{k=1}^{l}\alpha_{3j}(s_t)r_{t-k} + v(s_t)u_{ch,t} \quad [5]$$

$$r_t = \beta_1 + \sum_{k=1}^{l}\beta_{2j}(s_t)r_{t-k} + \sum_{k=1}^{l}\beta_{3j}(s_t)ch_{t-k} + v(s_t)u_{r,t} \quad [6]$$

$$us_t = \alpha_1 + \sum_{k=1}^{l}\alpha_{2j}(s_t)us_{t-k} + \sum_{k=1}^{l}\alpha_{3j}(s_t)r_{t-k} + v(s_t)u_{us,t} \quad [7]$$

$$r_t = \beta_1 + \sum_{k=1}^{l} \beta_{2j}(s_t) r_{t-k} + \sum_{k=1}^{l} \beta_{3j}(s_t) us_{t-k} + v(s_t) u_{r,t} \quad [8]$$

where ch_t and us_t represent the stock market volatility of the Chinese and American market, respectively, r_t is the volatility of the rest of the stock markets; u_t is the innovation process with a $v(s_t)$ variance which depends on s_t regime, which follows an ergodic Markov process with two regimes, defined by probability transition p_{ij} between those regimes.

The use of MS-VAR evades the arbitrary selection of the crisis episodes to one that endogenizes the process splitting up crisis from calm periods. Therefore, the discussion about the sample selection bias is evaded which other analyses of contagion are subjected to (Pontines & Siregar, 2009).

Finally, once the smooth probability of being in a high volatility period is obtained, a multiple structural breaks test is applied to identify the exact moment of regime change.

3. Results

Appendix A.1 presents descriptive statistics of the series; mean intraday returns are negative, skewed, leptokurtic, thus, non-normally distributed. Appendix A.2 shows ADF results, the null hypothesis is: series have unit root. In all the cases, the series are stationary.

GARCH model results are presented in Appendix A.3, APARCH model with t-Student innovations is the most suitable to model to capture the indexes behavior (seven of the thirteen series). APARCH model introduced by Ding et al. (1993) allows measuring asymmetric effects and non-normality, both are important characteristics of financial series.

To begin with the MS-VAR estimation, it is necessary to determine the lag length. Based on Likelihood Ratio (LR) tests of alternative lengths, a lag length of 1 was chosen to estimate the model. Secondly, the LR and AIC tests are applied to demonstrate that regime-switching behavior exists in the linkages of stock and exchange rate markets, the results are presented in Appendix A.4.

The evidence proves that LR tests reject the null hypothesis of no regime switching in the relationship between the stock market and exchange rate returns in all cases; it means that the alternative MS-VAR is the more-suitable model. The Akaike Information Criterion (AIC) also favors the MS-VAR model in all cases. Hence, MS-VAR is estimated, the results are in Tables 1 and 2.

Table 1. MS-VAR Results The US vs The Rest of the Countries.

Index	α_1	α_{21}	α_{22}	α_{31}	α_{32}	β_1	β_{21}	β_{22}	β_{31}	β_{32}	P_{11}	P_{22}	Average duration		Standard Deviation SYP		Standard Deviation Rest of the Countries	
													Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
CAC	5.62E-08 *	0.981488 *	0.955490 *	0.001931 *	0.002559 *	1.08E-07 *	0.962836 *	0.972612 *	0.007154 ***	0.000559 **	0.867503	0.967988	7.547355	31.23814	-14.34475	-18.29103	-14.14528	-17.56287
	(9.30E-09)	(0.002734)	(0.000658)	(0.003391)	(0.000403)	(1.64E-08)	(0.004649)	(0.000798)	(0.003859)	(0.000295)								
DAX	5.76E-08 *	0.980184 *	0.955342 *	0.003438 *	0.002837 *	2.99E-08 ***	0.971863 *	0.963597 *	0.022705 *	0.000863 *	0.898985	0.942974	9.899541	17.53593	-14.34491	-18.29143	-14.03354	-17.6826
	(9.20E-09)	(0.002756)	(0.000746)	(0.00315)	(0.000507)	(1.69E-08)	(0.004791)	(0.000676)	(0.004292)	(0.000263)								
DJI	2.70E-08 *	0.903824 *	0.902992 *	0.068428 *	0.045191 *	9.21E-08 *	1.057556 *	0.956614 *	-0.095765 *	0.009388 **	0.90876	0.958976	10.96012	24.37591	-14.35182	-18.31722	-14.10742	-17.93267
	(9.60E-09)	(0.012626)	(0.003702)	(0.009939)	(0.003216)	(1.25E-08)	(0.01248)	(0.00556)	(0.015795)	(0.006263)								
FTSEMIB	5.26E-08 *	0.977585 *	0.956306 *	0.009365 *	0.001338 *	3.60E-08 ***	0.939677 *	0.945687 *	0.032287 *	0.000688 *	0.82258	0.966929	5.636333	30.23788	-14.34663	-18.29341	-13.59808	-17.29169
	(9.15E-09)	(0.002537)	(0.000623)	(0.002717)	(0.00031)	(3.06E-08)	(0.006713)	(0.001057)	(0.006701)	(0.000255)								
HSI	4.83E-08 ***	0.979158 *	0.957381 *	0.000274 *	1.87E-06 ***	3.21E-05 *	0.741978 *	0.79859 *	1.781209 *	0.132372 *	0.955637	0.942646	22.54151	17.43547	-14.34774	-18.2927	-9.075519	-11.8311
	(9.14E-09)	(0.002202)	(0.000646)	(5.21E-05)	(2.92E-06)	(2.29E-06)	(0.010856)	(0.005282)	(0.496251)	(0.041369)								
IBEX	4.67E-08 *	0.981087 *	0.958542 *	0.003765 ***	-0.00041	1.11E-07 *	0.976007 *	0.967969 *	0.015216 *	0.003292 *	0.902476	0.968714	10.25392	31.963	-14.25391	-17.9794	-14.04241	-16.95622
	(1.20E-08)	(0.002674)	(0.000819)	(0.001925)	(0.000258)	(1.72E-08)	(0.002622)	(0.000941)	(0.0034)	(0.000627)								
IBOV	5.90E-08 *	0.984346 *	0.957572 *	-0.000665 *	-0.00011 *	1.58E-07 ***	0.927007 *	0.882678 *	0.532268 *	0.006913 *	0.332303	0.915367	10.84816	21.36848	-14.34548	-18.28908	-10.4703	-16.62893
	(9.05E-09)	(0.002197)	(0.000619)	(0.000191)	(2.22E-05)	(9.08E-07)	(0.01366)	(2.75E-05)	(0.1802)	(0.000361)								
IPC	5.63E-08 *	0.984359 *	0.957501 *	-0.001166 *	-5.42E-05 ***	9.85E-07 ***	0.821947 *	0.822443 *	0.069184 ***	0.002871 *	0.342044	0.933408	1.519859	15.01693	-14.34657	-18.2919	-10.599	-17.46422
	(9.07E-09)	(0.002202)	(0.000627)	(0.000326)	(2.69E-05)	(7.42E-07)	(0.015632)	(3.30E-05)	(0.148885)	(0.000129)								
IPSA	5.64E-08 *	0.977548 *	0.957737 *	1.55E-06 *	-5.20E-08 **	0.001069 *	0.961729 *	0.981697 *	61.48942	3.304195 *	0.511527	0.962179	2.047197	26.44001	-14.34636	-18.2923	-4.696605	-10.00044
	(9.00E-09)	(0.002584)	(0.000673)	(4.77E-07)	(1.62E-08)	(0.000302)	(0.007811)	(0.000118)	(56.37626)	(0.247552)								
KOSPI	5.81E-08 *	0.982287 *	0.957014 *	2.55E-05	9.47E-05 *	2.35E-07	0.699357 *	0.682107 *	0.811459	0.003362 *	0.308086	0.942252	1.445267	17.31663	-14.346	-18.29446	-9.522355	-16.29162
	(9.04E-09)	(0.002141)	(0.000614)	(0.000147)	(2.68E-05)	(2.58E-06)	(0.032684)	(2.97E-05)	(0.557092)	(0.000312)								
MERVAL	5.80E-08 *	0.982372 *	0.957419 *	-4.89E-06	-1.28E-05	1.36E-05 *	0.790204 *	0.916323 *	-0.571385	0.00687 *	0.605582	0.970722	2.535381	34.15573	-14.3458	-18.29267	-9.049263	-15.56482
	(9.00E-09)	(0.002171)	(0.000631)	(8.21E-05)	(1.03E-05)	(3.65E-06)	(0.016986)	(0.000845)	(0.688969)	(0.000795)								
SPTSX	4.97E-08 *	0.987668 *	0.957816 *	-0.000842 *	-0.000173 **	2.00E-07	0.859977 *	0.861633 *	0.212196	0.010448 *	0.504476	0.933671	2.018066	15.07634	-14.35017	-18.29331	-9.728635	-17.29392
	(9.07E-09)	(0.002221)	(0.000606)	(0.000111)	(6.60E-05)	(1.83E-06)	(0.013258)	(1.48E-05)	(0.315262)	(0.000247)								
UKX	5.49E-08 *	0.984919 *	0.957546 *	-0.000459 *	0.000116	1.24E-06	0.797882 *	0.82922 *	0.112264	0.009229 *	0.504005	0.947069	-9.173971	-17.03397	2.01615	18.89237	-14.34817	-18.29315
	(9.05E-09)	(0.002168)	(0.000632)	(8.12E-05)	(6.78E-05)	(2.88E-06)	(0.029521)	(1.02E-05)	(0.498518)	(0.000285)								

Source: Own elaboration with estimation results. Reported values are statistical significance levels of * 1%, ** 5% and 10% ***. Standard deviations are reported in parentheses.

Table 2. MS-VAR Results China vs Rest of the Countries.

Index	α_1	α_{21}	α_{22}	α_{31}	α_{32}	β_1	β_{21}	β_{22}	β_{31}	β_{32}	P_{11}	P_{22}	Average Duration		SD China		SD Rest of the Markets	
													Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
CAC	3.62E-05 *	0.741366 *	0.804733 *	1.155371	0.121568 **	3.78E-09 *	0.966964 *	9.73E-01 *	9.01E-05 *	6.70E-07 *	0.867869	0.968117	7.568252	31.36483	-8.97581	-11.7839	-14.14438	-17.56126
	(2.67E-06)	(0.012239)	(0.005525)	(0.758791)	(0.051905)	(2.84E-10)	(0.003744)	(6.86E-04)	(6.56E-05)	(4.99E-06)								
DAX	2.72E-05 *	0.778641 *	0.805947 *	1.071796 **	0.123237 **	5.16E-09 *	0.975421 *	9.66E-01 *	0.000165 ***	5.49E-06	0.536487	0.949398	2.157436	19.76198	-9.07091	-11.8089	-14.03782	-17.62098
	(2.32E-06)	(0.011048)	(0.005497)	(0.588886)	(0.051411)	(2.57E-10)	(0.004119)	(5.84E-04)	(9.37E-05)	(5.76E-06)								
DJI	3.14E-05 *	0.738259 *	0.808017 *	1.006833 *	0.12893 *	3.17E-09 *	0.979957 *	0.964883 *	0.000331 *	4.15E-07	0.90913	0.959051	11.00474	24.4206	-9.04687	-11.8036	-14.107	-17.93386
	(2.41E-06)	(0.011216)	(0.005716)	(0.405309)	(0.035139)	(2.10E-10)	(0.00225)	(0.000779)	(6.68E-05)	(3.89E-06)								
FTSEMIB	0.756321 *	0.805448 *	-1.35218 **	0.080672 *	0.979957 *	5.69E-08 *	0.979957 *	0.964883 *	0.000331 *	4.15E-07	0.90913	0.959051	6.511538	28.97495	-8.96917	-11.7821	-13.59918	-17.3027
	(0.012575)	(0.005507)	(0.630048)	(0.046531)	(0.00225)	(1.20E-08)	(0.00225)	(0.000779)	(6.68E-05)	(3.89E-06)								
IBEX	2.62E-05 *	0.743917 *	0.806813 *	2.044662 *	0.107326 *	1.33E-07 *	0.981331 *	0.969697 *	-3.56E-05	6.81E-07	0.333718	0.91016	1.534784	11.13094	-9.05458	-11.801	-14.04042	-16.95669
	(3.30E-05)	(0.011059)	(0.005422)	(0.398617)	(0.027666)	(1.70E-08)	(0.002422)	(0.000882)	(8.09E-05)	(9.89E-06)								
IBOV	2.56E-06 *	0.754253 *	0.806822 *	-0.06857	-0.0031	1.28E-06 ***	0.941522 *	0.882862 *	0.000325	3.54E-05 *	0.348442	0.917953	1.500865	12.18811	-10.5052	-16.6831	-8.962804	-11.78088
	(7.51E-07)	(0.01184)	(0.005518)	(0.063488)	(0.002988)	(7.51E-07)	(0.012912)	(2.51E-05)	(0.005215)	(8.87E-06)								
IPC	2.40E-05 **	0.822875 *	0.804465 *	-0.34163 **	-0.00079	3.02E-07 *	0.826377 *	0.822641 *	0.001469 *	1.35E-05 *	0.370518	0.930862	1.588608	14.46381	-9.07785	-11.8145	-10.60786	-17.47398
	(1.03E-05)	(0.089375)	(0.018741)	(0.173568)	(0.015217)	(6.94E-07)	(0.016049)	(2.92E-05)	(0.003451)	(2.75E-06)								
IPSA	3.50E-05 *	0.772056 *	0.805505 *	-0.00055 *	1.70E-05 *	0.000295 *	0.970275 *	0.982306 *	4.04148 *	0.032777 *	0.510565	0.961735	2.043173	26.13333	-8.99823	-11.7902	-4.706088	-10.00551
	(2.51E-06)	(0.01158)	(0.005436)	(0.000103)	(7.01E-06)	(0.000277)	(0.006394)	(0.000118)	(1.287257)	(0.004667)								
KOSPI	1.86E-05 *	0.874387 *	0.804922 *	-0.16364 *	0.001252 *	2.50E-06	0.693124 *	0.682042 *	0.00248	6.33E-05 *	0.447704	0.948853	1.810623	19.55148	-9.08927	-11.8152	-9.448876	-16.19705
	(2.82E-06)	(0.001581)	(0.002281)	(0.01659)	(0.005692)	(2.37E-06)	(0.032741)	(0.000117)	(0.012453)	(9.55E-06)								
MERVAL	3.09E-05 *	0.787832 *	2.81E-06 *	-0.23549 *	-0.00754 *	9.71E-06 *	0.770343 ***	0.918584 *	0.040483 *	3.68E-05 **	0.605014	0.970464	2.531736	33.85753	-8.98353	-11.7841	-9.054393	-15.56718
	(3.59E-06)	(0.004374)	(9.31E-08)	(0.009682)	(0.000757)	(3.24E-06)	(0.017424)	(0.000853)	(0.017176)	(1.77E-05)								
SPTSX	3.71E-05 *	0.73051 *	2.67E-06 *	-0.04539	-0.00312	1.14E-05	0.851586 *	1.43E-08 *	-0.01214	3.73E-05 *	0.450127	0.942087	1.818601	17.26738	-9.01551	-11.7928	-9.05871	-17.12497
	(3.36E-06)	(0.002086)	(9.47E-08)	(0.081366)	(0.002476)	(8.90E-06)	(0.009342)	(1.16E-09)	(0.009706)	(1.45E-05)								
SPX	3.27E-05 *	0.717443 *	0.806629 *	1.796017 *	0.15499 *	5.65E-08 *	0.978828 *	0.957046 *	0.000285 *	9.54E-07	0.900753	0.951426	10.07586	20.58734	-8.9766	-11.784	-18.2977	-14.33503
	(4.04E-06)	(0.003203)	(0.002173)	(0.626257)	(0.028908)	(9.34E-09)	(0.002236)	(0.000598)	(5.27E-05)	(2.90E-06)								
UKX	2.90E-05 *	0.782628 *	2.81E-06 *	-0.07148 *	-0.00042 *	1.14E-05 *	0.826182 *	0.831567 *	-0.00808	9.12E-05 *	0.367763	0.950137	1.581685	20.05502	-9.0722	-11.8106	-9.009598	-16.9496
	(2.94E-06)	(0.001977)	(9.50E-08)	(0.016298)	(0.00321)	(3.40E-06)	(0.017113)	(4.67E-05)	(0.014382)	(5.48E-06)								

Source: Own elaboration with estimation results. Reported values are statistical significance levels of * 1%, ** 5% and 10% ***. Standard deviations are reported in parentheses.

Table 1 shows results for the US market. The standard deviation of the stock markets is lower in regime one (low volatility regime) than in regime two (high volatility regime), for all the markets. It indicates the presence of two different volatility regimes. Average duration results evidence that the high volatility periods lasts less than low volatility periods, which is consistent with the expected result; crisis periods are shorter than calm episodes.

The estimated coefficients capturing the impact of the international stock markets volatility on the US stock market volatility (α_{31} and α_{32}) are statistically significant, for almost all the market's volatility except for the Spanish, Korean, Argentinian and British economies, in other words, there is a significant effect of the international markets' volatility on the US market.

On the other hand, the coefficients (β_{31} and β_{32}) capture the effects of the US stock market volatility on the rest of the volatility stock markets. They are not statistically significant in the cases of Peru, Korea, Argentina, Canada and the UK; this means the US volatility market does not have a significant impact on these markets' volatility.

Table 2 presents the results for the Chinese market. The estimated coefficients capturing the impact of the international stock markets volatility on Chinese stock market volatility (α_{31} and α_{32}) are statistically significant, for almost all the relations except for the French, Brazilian, Mexican and Canadian markets; in other words, there is a significant effect of the international markets on the Chinese market.

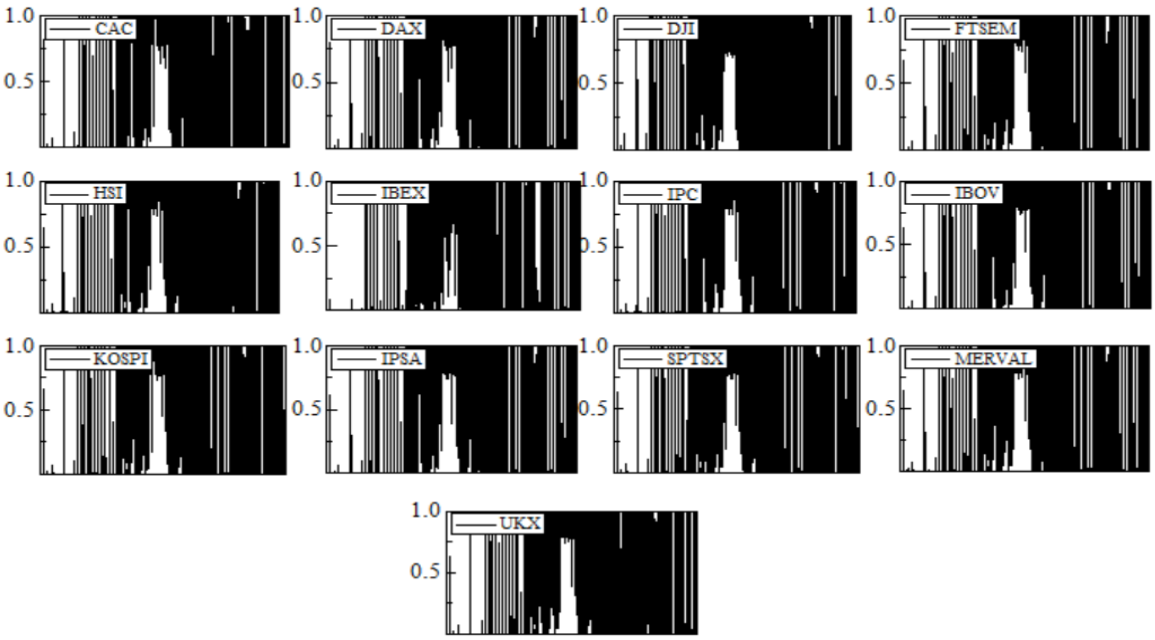
Further, the coefficients (β_{31} and β_{32}) capture the effects of the Chinese stock market volatility on the rest of the volatility stock markets. They are not significant for the Dow Jones (US), FTSEMIB (Italy), IBEX (Spain), IBOV (Brazil), KOSPI (Korea), Canada (SPTSX), SPX (US) and UKX (UK).

These findings confirm that, despite the fact that China has had an increasing role in the economy and financial markets, the US market still influence more markets, in relation to the Chinese market.

Figure 1 shows the graphic analysis from the smooth probability of being in high volatility for each relation US *vs* the rest of the markets. It is observed alike behavior among the different markets. For all the economies the probability of being in high volatility level increased after January 29th when the number of Covid19 cases augmented and flights to China were suspended.

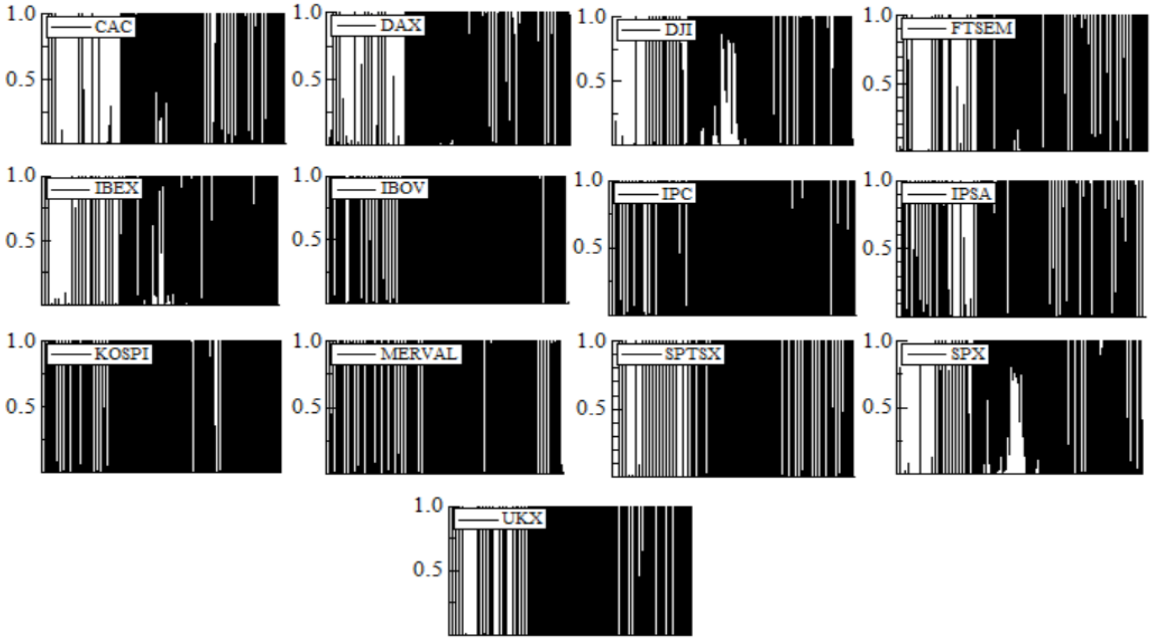
In Figure 2 it is observed the smooth probability of being in high volatility for each linkage between Chinese market volatility and the rest of the indices volatility. European, American, and Canadian markets display similar behavior, but the rest of the markets have different performance. It seems that developed countries´ markets have a similar reaction to Chinese market volatility, and developing ones react differently according to their own characteristics and local situations.

Figure 1. Smooth probability of being in high volatility level MSVAR model results for the influence from the US to the rest of the markets.



Source: Own elaboration with estimation results.

Figure 2. Smooth probability of being in high volatility level MSVAR model results for the influence from the Chinese volatility market to the rest of the volatility markets.



Source: Own elaboration with estimation results.

Once the graphic analysis is elaborated, the multiple structural break test is applied on smooth probabilities series to confirm whether all markets present coincident dates. In other words, we test when series exhibit changes to confirm common structural break dates.

Table 3 shows the results of structural breaks. Findings sign the existence of four structural breaks in the models, both in the sequential, as well as in the repartition structural detection. For all the relationships dates coincide, showing as key days: January 29th, March 9th, April 1st, and April 28th. These dates match with the following events: January 29th the number of infected increased and flights to China were suspended (Regan et al., 2020 and Reuters, January 30, 2020); March 9th economy and financial markets crashed, Italy closed its borders, a prices war started between Saudi Arabia and Russia, that day was called Black Monday (Li, 2019; Bayly, 2020 and BBC, 2020). April 1st the US bonds yield diminished (Smith, 2020) and the oil price fell (Reuters, April 1st, 2020) and, April 28th the US had more than 1 million of confirmed cases and Trump began to blame China for the virus generation and propagation (Davidson & Rourke, 2020, and Bloomberg, 2020).

The results reveal the presence of four structural breaks in the model, in both strategies: sequential and repartition.

Table 3. Multiple Structural Break Test Results – Chinese Market *vs* The Rest.

Index	Break Test	Sequential		Repartition		F-Statistic
		Date	Base Time	Date	Base Time	
CAC	1	09/03/20	03:41	29/01/20	04:31	1104.457
	2	01/04/20	05:06	09/03/20	03:42	3246.071
	3	29/01/20	04:31	01/04/20	05:06	75.17666
	4	28/04/20	06:28	28/04/20	06:28	60.36416
DAX	1	09/03/20	03:28	29/01/20	04:33	1103.892
	2	01/04/20	05:04	09/03/20	03:28	3220.161
	3	29/01/20	04:33	01/04/20	05:04	82.75519
	4	28/04/20	06:30	28/04/20	06:30	69.1374
DJI	1	09/03/20	08:54	29/01/20	11:01	1103.957
	2	01/04/20	11:32	09/03/20	08:54	3218.928
	3	29/01/20	11:01	01/04/20	11:32	80.4462
	4	28/04/20	12:58	28/04/20	12:58	66.2677
FTSEM	1	09/03/20	03:28	29/01/20	04:31	1109.083
	2	01/04/20	05:02	09/03/20	03:28	3271.699
	3	29/01/20	04:31	01/04/20	05:02	74.77268
	4	28/04/20	06:28	28/04/20	06:28	59.95135
IBEX	1	09/03/20	08:57	29/01/20	09:31	1097.645
	2	01/04/20	11:03	09/03/20	08:57	3196.391
	3	29/01/20	09:31	01/04/20	11:03	80.96089
	4	28/04/20	12:28	28/04/20	12:28	65.95897
IBOV	1	09/03/20	08:57	29/01/20	09:31	1111.614
	2	01/04/20	11:03	09/03/20	08:57	3283.892
	3	29/01/20	09:31	01/04/20	11:03	74.07525
	4	28/04/20	12:28	28/04/20	12:28	59.49673
IPC	1	09/03/20	08:41	29/01/20	11:01	1110.659
	2	01/04/20	11:10	09/03/20	08:41	3236.32
	3	29/01/20	11:01	01/04/20	11:10	83.24828
	4	28/04/20	12:58	28/04/20	12:58	73.34091
IPSA	1	09/03/20	07:54	29/01/20	09:02	1109.26
	2	01/04/20	10:32	09/03/20	07:54	3267.565
	3	29/01/20	09:02	01/04/20	10:32	76.99056
	4	28/04/20	12:58	28/04/20	12:58	62.40843
KOSPI	1	09/03/20	18:38	29/01/20	20:00	1109.624
	2	01/04/20	21:07	09/03/20	18:38	3234.934
	3	29/01/20	20:00	01/04/20	21:07	84.30128
	4	28/04/20	21:57	28/04/20	21:57	74.20303
MERVAL	1	09/03/20	09:24	29/01/20	10:31	1112.403
	2	01/04/20	12:02	09/03/20	09:24	3290.493
	3	29/01/20	10:31	01/04/20	12:02	74.26886
	4	28/04/20	13:28	28/04/20	13:28	58.34187
SPTSX	1	09/03/20	08:54	29/01/20	11:01	1115.629
	2	01/04/20	11:32	09/03/20	08:54	3252.891
	3	29/01/20	11:01	01/04/20	11:32	75.32037
	4	28/04/20	12:58	28/04/20	12:58	62.46872
SPX	1	09/03/20	08:54	29/01/20	11:01	1103.618
	2	01/04/20	11:32	09/03/20	08:54	3233.335
	3	29/01/20	11:01	01/04/20	11:32	74.9844
	4	28/04/20	12:58	28/04/20	12:58	59.97789
UKX	1	09/03/20	03:23	29/01/20	04:31	1111.834
	2	01/04/20	05:02	09/03/20	03:23	3253.496
	3	29/01/20	04:31	01/04/20	05:02	82.48048
	4	28/04/20	06:28	28/04/20	06:28	69.57041

Source: Own elaboration with estimation results.

Table 4 shows the multiple structural breaks test results in the dynamic relationships between the S&P 500 and other indexes. For almost all the markets, except the Spanish market, four structural breaks are statistically significant for sequential and repartition strategies. As in the Chinese case, four dates were coincident for all the markets: February 20th, April 16th, May 19th, and March 19th.

Table 4. Multiple Structural Break Test Results – American Market *vs* The Rest.

Index	Break Test	Sequential		Repartition		F-statistic
		date	base time*	date	base time	
CAC	1	20/02/20	06:59	20/02/20	06:59	6481.056
	2	16/04/20	05:36	19/03/20	03:12	18046.36
	3	19/05/20	03:12	16/04/20	05:36	617.0621
	4	19/03/20	03:12	19/05/20	03:12	403.2008
DAX	1	20/02/20	07:01	20/02/20	07:01	6483.66
	2	16/04/20	05:38	19/03/20	03:09	18017.96
	3	19/05/20	03:12	16/04/20	05:38	610.6155
	4	19/03/20	03:09	19/05/20	03:12	395.0586
DJI	1	20/02/20	13:29	20/02/20	13:29	6600.851
	2	16/04/20	12:06	19/03/20	08:37	17637.09
	3	19/05/20	09:42	16/04/20	12:06	594.926
	4	19/03/20	08:37	19/05/20	09:42	366.6275
FTSEM	1	20/02/20	06:59	20/02/20	06:59	6512.875
	2	16/04/20	05:36	19/03/20	03:07	18036.22
	3	19/05/20	03:12	16/04/20	05:36	613.9972
	4	19/03/20	03:07	19/05/20	03:12	404.7249
HSI	1	20/02/20	23:05	20/02/20	23:05	6520.018
	2	16/04/20	20:46	19/03/20	01:07	18082.08
	3	19/05/20	01:12	16/04/20	20:46	615.95
	4	19/03/20	01:07	19/05/20	01:12	411.1631
IBEX	1	20/02/20	11:59	20/02/20	11:59	5058.89
	2	08/04/20	09:42	08/04/20	09:42	18761.51
	3	19/05/20	09:12	19/05/20	09:12	554.7363

Index	Break Test	Sequential		Repartition		F-statistic
		date	base time*	date	base time	
IBOV	1	20/02/20	11:59	20/02/20	11:59	6489.974
	2	16/04/20	11:36	19/03/20	08:07	18139.51
	3	19/05/20	09:12	16/04/20	11:36	607.0262
	4	19/03/20	08:07	19/05/20	09:12	416.5044
IPC	1	20/02/20	13:29	20/02/20	13:29	6514.797
	2	16/04/20	12:06	19/03/20	08:37	18097.34
	3	19/05/20	09:42	16/04/20	12:06	616.3829
	4	19/03/20	08:37	19/05/20	09:42	411.27
IPSA	1	20/02/20	11:36	20/02/20	11:36	6514.994
	2	16/04/20	12:06	19/03/20	07:37	18096.61
	3	19/05/20	09:42	16/04/20	12:06	617.1141
	4	19/03/20	07:37	19/05/20	09:42	412.2168
KOSPI	1	20/02/20	22:28	20/02/20	22:28	6517.005
	2	16/04/20	21:03	19/03/20	18:34	18047.06
	3	19/05/20	01:12	16/04/20	21:03	615.7077
	4	19/03/20	18:34	19/05/20	01:12	412.1214
MERVAL	1	20/02/20	12:59	20/02/20	12:59	6515.289
	2	16/04/20	12:36	19/03/20	09:07	18081.8
	3	19/05/20	10:12	16/04/20	12:36	613.7782
	4	19/03/20	09:07	19/05/20	10:12	411.2326
SPTSX	1	20/02/20	13:29	20/02/20	13:29	6524.401
	2	16/04/20	12:06	19/03/20	08:37	18099.43
	3	19/05/20	09:42	16/04/20	12:06	620.4752
	4	19/03/20	08:37	19/05/20	09:42	409.037
UKX	1	20/02/20	06:59	20/02/20	06:59	6525.178
	2	16/04/20	05:36	19/03/20	03:07	18077.65
	3	19/05/20	03:12	16/04/20	05:36	616.0794
	4	19/03/20	03:07	19/05/20	03:12	415.1672

Source: Own elaboration with estimation results.

February 20th was declared the beginning of the 2020 stock market crash which ended on April 7 (ZACKS, April 7, 2020). At February 20th stock markets suffered important losses (Huang, February 20, 2020), oil prices fell by 1% (Verma, 2020) and yields of 10 year and 30-year U. S. Treasury securities fell to 1.51% and 1.96% respectively (Hyerczyk, 2020). On March 19th Asia-Pacific equity markets closed with losses (Huang, March 19, 2020) while European ones closed winning 3% (Ellyatt & Smith, 2020), oil prices rose by 23% and the yields on 10- year and 30-year U. S Treasury securities fell to 1.06% and 1.68% respectively. The FED announced foreign exchange swap lines for $450 billion in Australia, Brazil, South Korea, Mexico, Singapore, Sweden, Denmark, Norway and New Zealand Central Banks (60 billion for each) (Schneider & Dunsmuir, 2020). The FED also opened an additional lending facility alike to CPFF for money market mutual funds (Neuman, 2020). The Bank of England, the Denmark's National Bank (Reuters, March 19a, 2020), the South African Reserve Bank, Bank of Indonesia and the Central bank of the Republic of China (Loo & Lee, 2020) announced changes in their rates (Meredith, 2020). Chile (Reuters, March 19b, 2020) and the U.S (Hirsch and Pramuk, 2020) also announced a fiscal stimulus package.

On April 16th, benchmarks closed with losses after disappointing corporate earnings reports and weak economic data because of damage by the COVID19 outbreak. The DJI fell 1.9%, S&P500 2.2%, Nasdaq 1.4%. The fear-gauge CBOE Volatility Index (VIX) increased 7.5% (ZACKS, April 16, 2020). May 19th Wall street recovered on Monday after the disappointing results of potential coronavirus vaccine. Fed Chairman promised more stimulus to lift the pandemic-affected, this improves investors´ sentiments. DJI, S&P500 and Nasdaq closed up (ZACKS, May 19, 2020).

4. Conclusion

This paper modeled intraday volatility for 13 markets and analyzed the incidence of Chinese and American markets volatility in the rest of the stock markets´ volatility, pointing out the breakpoints, structural changes on the probability of being in high volatility regime; and contagion episodes.

To achieve this purpose, we estimated the stock index returns volatility employing GARCH extensions and GAS model. Volatility measure results indicated the APARCH model is the most suitable for a major part of the equity indexes. Once volatility was modeled, conditional variance was employed to test the incidence of the Chinese and the U.S. stock market volatility on the rest of the markets; MS-VAR was proposed to analyze two-ways volatility incidence.

MS-VAR models evidence, for almost all the stock markets, a significant two-ways incidence, which evolves according to two regimes: high volatility regime, and low volatility regime. Finally, MS-VAR smooth probabilities of being in high volatility regime series are used to detect structural changes, i.e., to find the exact dates when the high volatility period started. Those dates could also be identified as moments when contagion periods started.

The findings confirm that, even though China has had an increasing role in the economy and in the financial markets, the US market still maintains greater influence on more markets than the Chinese market does.

Multiple break test reveals which dates were relevant for each market: Chinese and American. Results also allowed to observe in which days mutual incidence of the stock markets was took place, provoking high volatility periods

The empirical evidence is of outmost importance in terms of widening the knowledge about the volatility contagion effect between the American and the Chinese stock markets, as well as the rest of the stock markets analyzed, during the COVID19 immediate effects.

Future studies agenda could include research about the contagion effect on other financial markets, the period of study might be extended or the application of other methodologies could be incorporated.

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Appendix

A. Indexes under analysis

Exchange	CAC	DAX	DJI	FTSEMIB	HSI	IBEX	SPX
Country	France	Germany	US	Italy	China	Spain	US
Exchange	IBOV	IPC	IPSA	KOSPI	MERVAL	SPTSX	UKX
Country	Brasil	Mexico	Chile	South Korea	Argentina	Canada	UK

A.1 Descriptive Statistics and Jarque Bera Test

Index	Mean	Std. Dev.	Variance	Skewness	Kurtosis	Jarque Bera
CAC	-9.15E-06	0.001901	3.6138E-06	11.26923	2630.728	6.04E+09
DAX	-3.26E-06	0.00209	4.3681E-06	20.97047	3135.684	8.59E+09
DJI	-4.19E-06	0.001747	3.052E-06	-10.85129	778.0992	5.26E+08
FTSEMIB	-9.34E-06	0.00173	2.9929E-06	5.500584	2018.201	3.55E+09
HSI	-6.87E-06	0.001236	1.5277E-06	-12.99589	1051.383	9.62E+08
IBEX	-9.44E-06	0.001771	3.1364E-06	-5.992889	375.6784	1.22E+08
IBOV	-9.44E-06	0.001799	3.2364E-06	-4.793483	377.9036	1.23E+08
IPC	-7.85E-06	0.001097	1.2034E-06	-18.13612	1130.288	1.11E+09
IPSA	-9.17E-06	0.001694	2.8696E-06	-38.27363	3595.616	1.13E+10
KOSPI	-7.31E-07	0.001498	2.244E-06	14.92455	1655.373	2.39E+09
MERVAL	-2.64E-06	0.002214	4.9018E-06	-10.99809	1064.683	9.87E+08

SPTSX	-4.49E-06	0.001456	2.1199E-06	-27.66239	1828.125	2.92E+09
SPX	-1.59E-06	0.001584	2.5091E-06	-13.20149	907.5612	7.17E+08
UKX	-9.63E-06	0.001632	2.6634E-06	-16.55178	2649.833	6.13E+09

A.2 ADF Test Results

	ADF Test Results					
	Level			First Differences		
	Intercept	Intercept and Trend	None	Intercept	Intercept and Trend	None
CAC	-143.87 ***	-143.87 ***	-143.87 ***	-37.545 ***	-37.544 ***	-37.546 ***
DAX	-144.56 ***	-144.56 ***	-144.56 ***	-36.999 ***	-36.998 ***	-37.000 ***
DJI	-144.33 ***	-144.33 ***	-144.33 ***	-40.251 ***	-40.250 ***	-40.252 ***
FTSEMIB	-140.98 ***	-140.98 ***	-140.98 ***	-39.091 ***	-39.090 ***	-39.092 ***
HSI	-141.90 ***	-141.90 ***	-141.90 ***	-37.597 ***	-37.596 ***	-37.598 ***
IBEX	-30.71 ***	-30.74 ***	-30.71 ***	-36.454 ***	-36.453 ***	-36.455 ***
IBOV	-30.63 ***	-30.66 ***	-30.63 ***	-36.150 ***	-36.149 ***	-36.151 ***
IPC	-96.60 ***	-96.61 ***	-96.60 ***	-38.573 ***	-38.572 ***	-38.574 ***
IPSA	-144.32 ***	-144.32 ***	-144.31 ***	-36.733 ***	-36.732 ***	-36.734 ***
KOSPI	-99.15 ***	-99.15 ***	-99.15 ***	-40.375 ***	-40.374 ***	-40.376 ***
MERVAL	-74.19 ***	-74.19 ***	-74.19 ***	-38.740 ***	-38.739 ***	-38.741 ***
SPTSX	-79.40 ***	-79.40 ***	-79.40 ***	-36.583 ***	-36.582 ***	-36.584 ***
SPX	-141.86 ***	-141.86 ***	-141.86 ***	-39.739 ***	-39.738 ***	-39.740 ***
UKX	-142.38 ***	-142.38 ***	-142.38 ***	-37.950 ***	-37.949 ***	-37.949 ***

Note: *** statistical significance at 1%, respectively

A.3 LR and AIC tests statistics results

Index	LnL(AR)	LnL(MS-AR)	LR	AIC (AR)	AIC(MS-AR)
CAC	101771.2	123895.2	44248	-9.692862	-11.79944
DAX	99785.2	123873.1	48175.8	-9.50371	-11.79743
DJI	103548.1	122252.6	37409	-9.862102	-11.64309
FTSEMIB	103752.4	123511.3	39517.8	-9.881557	-11.76297
HSI	110816.3	131653.3	41674	-10.55434	-12.53843
IBEX	103253.7	117642.3	28777.2	-9.834063	-11.20399
IBOV	102924.5	117633.1	29417.2	-9.802707	-11.20311
IPC	113307.1	130706.3	34798.4	-10.79157	-12.44824
IPSA	104194.4	128723.8	49058.8	-9.923657	-12.25941
KOSPI	106778.7	123713	33868.6	-10.16979	-11.78218
MERVAL	98566.39	116584.3	36035.82	-9.387627	-11.10323
SPTSX	107366.7	128953.3	43173.2	-10.22579	-12.28128
SPX	105598.8	128953.7	46709.8	-10.05741	-12.28132
UKX	104968.7	128695.4	47453.4	-9.997398	-12.25672

Table A.4. Appendix

CAC								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	103367.2	-9.844581	-9.844087	0.615000	1.000000		*
	GED	127911.8	-12.18218	-12.18156	1.000000	1.000000		*
	STUDENT	129235.8	-12.30828	-12.30766	1.000000	1.000000		*
ACGARCH	GAUSS	102656.2	-9.776672	-9.77593	0.013400	0.001323		
	GED	110208.8	-10.49582	-10.49483	0.031400	0.005621	+	*
	STUDENT	129204.4	-12.3051	-12.30423	0.001896	0.001896		
TARCH	GAUSS	104633	-9.965043	-9.964425	0.946000	1.000000		*
	GED	128042.8	-12.19456	-12.19382	1.000000	1.000000		*
	STUDENT	126523.2	-12.04983	-12.04909	0.689000	1.000000		
EGARCH	GAUSS	102335.4	-9.746221	-9.745603	1.000000	0.999900		*
	GED	128407.2	-12.22926	-12.22852	1.000000	1.000000		*
	STUDENT	129195	-12.3043	-12.30355	1.000000	1.000000		*
APARCH	GAUSS	107012	-10.19153	-10.19079	0.018800	0.002167		*
	GED	128583.3	-12.24594	-12.24508	0.004800	0.000466	+	
	STUDENT	**130274.4**	**-12.40701**	**-12.40615**	**0.007400**	**0.000722**	+	*
IGARCH	GAUSS	38911.37	-8.800808	-8.799989	0.998991	0.976700	+	*
	GED	57411.6	-12.985435	-12.984616	1.000000	1.000000		
	STUDENT	58396.5	-13.207758	-13.206393	1.000000	1.000000	+	*
FIGARCH	GAUSS	94902.253	-9.038264	-9.037646	0.999999	1.000000		
	GED	96791.374	-9.218094	-9.217352	1.000000	1.000000	+	
	STUDENT	118657.588	-11.300689	-11.299948	1.000000	1.000000		*
GAS	GAUSS	70260.7	-6.691433	-6.690939	0.999903	0.998100	+	*
	GED	70337.7	-6.698673	-6.698055	0.999931	0.998500	+	*
	STUDENT	121587	-11.5798	-11.579182	1.000000	1.000000	+	*

Note: Q^2 (10) and ARCH(5) denote the p-values of the tests.

DAX								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	102033	-9.71751	-9.717016	0.790000	1.000000	+	*
	GED	127940.8	-12.18504	-12.18455	1.000000	1.000000		*
	STUDENT	129370	-12.32106	-12.32045	1.000000	1.000000		*
ACGARCH	GAUSS	103659.8	-9.872161	-9.871296	0.026000	0.003122		*
	GED	127822.4	-12.17338	-12.17239	0.020900	0.002113		
	STUDENT	129241	-12.30858	-12.30772	0.004200	0.000430		*
TARCH	GAUSS	107227.5	-10.21215	-10.21153	0.734000	1.000000	+	*
	GED	127920.9	-12.18295	-12.18221	1.000000	1.000000		*
	STUDENT	129095.4	-12.29481	-12.29407	1.000000	1.000000	+	*
EGARCH	GAUSS	99945.7	-9.518616	-9.517998	1.000000	1.000000		*
	GED	128207.3	-12.21023	-12.20949	1.000000	1.000000		*
	STUDENT	129287.8	-12.31314	-12.3124	1.000000	1.000000		*
APARCH	GAUSS	104368.1	-9.939717	-9.938976	0.040200	0.006032	+	*
	GED	128457	-12.23392	-12.23305	0.003300	0.000329	+	
	STUDENT	**130274.4**	**-12.40701**	**-12.40615**	**0.007400**	**0.000722**	+	*
IGARCH	GAUSS	40175.445	-9.086959	-9.086413	1.000000	1.000000	+	*
	GED	57237	-12.945945	-12.945126	1.000000	1.000000		
	STUDENT	58150	-13.152013	-13.150648	1.000000	1.000000	+	*
FIGARCH	GAUSS	100055	-9.52894	-9.528198	1.000000	1.000000	+	*
	GED	95936.984	-9.136719	-9.135978	1.000000	1.000000	+	
	STUDENT	117719.347	-11.211329	-11.210587	1.000000	1.000000	+	
GAS	GAUSS	69103.8	-6.581246	-6.580752	0.999995	0.999600	+	*
	GED	68927	-6.564314	-6.563696	0.999996	0.999700	+	*
	STUDENT	123003	-11.714674	-11.714056	1.000000	1.000000	+	*

DJI								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	105900.9	-10.0859	-10.0854	0.961000	1.000000		*
	GED	127183.9	-12.11285	-12.11223	1.000000	1.000000		*
	STUDENT	128782.9	-12.26515	-12.26453	1.000000	1.000000		*
ACGARCH	GAUSS	105351.5	-10.03329	-10.03242	0.063600	0.007689	+	*
	GED	127013.4	-12.09633	-12.09534	0.029900	0.002952		
	STUDENT	128732.4	-12.26014	-12.25928	0.025000	0.002459		
TARCH	GAUSS	105908.7	-10.08655	-10.08593	0.962000	1.000000	+	*
	GED	127207.1	-12.11497	-12.11422	1.000000	1.000000		*
	STUDENT	128805.8	-12.26723	-12.26649	1.000000	1.000000	+	*
EGARCH	GAUSS	109049.3	-10.38567	-10.38505	1.000000	0.999900		*
	GED	127354.3	-12.12899	-12.12825	0.997000	1.000000		*
	STUDENT	128545.6	-12.24245	-12.24171	1.000000	1.000000		
APARCH	GAUSS	109023.9	-10.38316	-10.38241	0.017600	0.001228	+	
	GED	127792.2	-12.1706	-12.16973	0.024100	0.002301	+	*
	STUDENT	**129595.8**	**-12.34238**	**-12.34151**	**0.023900**	**0.002279**	+	*
IGARCH	GAUSS	45220.547	-10.228353	-10.22808	1.000000	1.000000		
	GED	57242.827	-12.947258	-12.946439	1.000000	1.000000		
	STUDENT	58226.421	-13.169288	-13.167923	1.000000	1.000000	+	
FIGARCH	GAUSS	97240	-9.261012	-9.260517	0.999998	0.999900		
	GED	100880.444	-9.607547	-9.606806	1.000000	1.000000	+	
	STUDENT	119674.924	-11.397583	-11.396841	1.000000	1.000000	+	
GAS	GAUSS	75285.5	-7.170007	-7.169513	0.995543	0.980600	+	*
	GED	75316.785	-7.172893	-7.172275	0.997025	0.985400	+	*
	STUDENT	113002	-10.762087	-10.761469	1.000000	1.000000	+	*

FTSEMIB								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	104774.5	-9.978617	-9.978123	0.831000	1.000000		*
	GED	126466.9	-12.04456	-12.04394	0.979000	1.000000	+	*
	STUDENT	127580.5	-12.15063	-12.15001	0.995000	1.000000	+	*
ACGARCH	GAUSS	104184.2	-9.922106	-9.921241	0.026800	0.001627		*
	GED	126928.4	-12.08824	-12.08725	0.016600	0.001609		
	STUDENT	128374.7	-12.22607	-12.22521	0.012900	0.001238		
TARCH	GAUSS	105153.5	-10.01462	-10.01401	0.209000	1.000000		*
	GED	127005	-12.09572	-12.09498	0.999000	1.000000	+	*
	STUDENT	128408.6	-12.22949	-12.22887	1.000000	1.000000	+	*
EGARCH	GAUSS	104714.8	-9.972838	-9.97222	1.000000	1.000000		*
	GED	126879.8	-12.0838	-12.08305	0.999000	1.000000		*
	STUDENT	127917.7	-12.18264	-12.1819	0.999000	1.000000		*
APARCH	GAUSS	106528.2	-10.14546	-10.14472	0.072600	0.008012		
	GED	127372.1	-12.13059	-12.12973	0.007900	0.000752	+	*
	STUDENT	**129009.7**	**-12.28656**	**-12.28569**	**0.007000**	**0.000659**	+	*
IGARCH	GAUSS	42728.9	-9.6643	-9.663481	1.000000	1.000000		
	GED	56374.2	-12.750782	-12.749963	1.000000	1.000000		
	STUDENT	57280.084	-12.955233	-12.953868	1.000000	1.000000	+	
FIGARCH	GAUSS	96585.236	-9.19846	-9.197719	1.000000	1.000000		
	GED	101443	-9.661155	-9.660413	1.000000	1.000000	+	
	STUDENT	109036	-10.384341	-10.3836	1.000000	1.000000	+	
GAS	GAUSS	74265.2	-7.072836	-7.072342	0.999920	0.998600	+	*
	GED	73942.6	-7.042015	-7.041397	0.999827	0.997600	+	*
	STUDENT	118237	-11.260751	-11.260133	1.000000	1.000000	+	*

HSI								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	113864.3	-10.84436	-10.84386	0.044	1		*
	GED	133767.3	-12.73987	-12.73925	0.024	0.9998		*
	STUDENT	117681.9	-11.20786	-11.20724	0.004	1		
ACGARCH1	GAUSS	112211.2	-10.68662	-10.68575	1.0683	0.00562	+	*
	GED	127812.5	-12.17244	-12.17145	0.0993	0.009882	+	*
	STUDENT	126091.3	-12.0086	-12.00774	0.0978	0.009755		*
TARCH	GAUSS	113977.1	-10.855	-10.85438	0.032	0.9999		*
	GED	133773.5	-12.74037	-12.73963	0.033	1		*
	STUDENT	133088.4	-12.67512	-12.67437	0.001	1	+	
EGARCH	GAUSS	113485	-10.80822	-10.80773	1	0.9999		*
	GED	133429.5	-12.70761	-12.70687	0.002	1		
	STUDENT	133413.7	-12.7061	-12.70536	1	1		*
APARCH	GAUSS	113528.3	-10.81216	-10.81142	0.871	0.011116		*
	GED	133792.6	-12.74209	-12.74123	2.4755	0.0998	+	
	STUDENT	**135830.4**	**-12.93618**	**-12.93532**	**0.0465**	**0.004667**	+	*
IGARCH	GAUSS	50276.2	-11.37122	-11.37013	0	0		
	GED	57775.8	-13.06782	-13.067	1	1		
	STUDENT	50251.3	-11.36559	-11.3645	1	1		
FIGARCH	GAUSS	104256.351	-9.929078	-9.928336	0.999995	0.9997		
	GED	106703.201	-10.16212	-10.16138	1	1	+	*
	STUDENT	95769.8	-9.120792	-9.120792	0.997491	0.9913		
GAS	GAUSS	81667.5	-7.777849	-7.777355	0.999337	0.994	+	*
	GED	82048.8	-7.814068	-7.81345	0.995376	0.9772	+	*
	STUDENT	87651.2	-8.347657	-8.347039	0.99996	0.9999	+	*

IBEX								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	107952.8	-10.28133	-10.28084	0.187000	1.000000		*
	GED	120420	-11.46864	-11.46802	0.403000	1.000000		*
	STUDENT	121142.6	-11.53746	-11.53685	0.412000	1.000000		*
ACGARCH	GAUSS	107613.2	-10.2487	-10.24783	0.007196	0.007196		*
	GED	120419.9	-11.46844	-11.46757	0.087400	0.008908		*
	STUDENT	113899.1	-10.84738	-10.84652	0.673	0.5118	+	*
TARCH	GAUSS	108442.9	-10.32791	-10.32729	0.111000	1.000000		*
	GED	99973.47	-9.521165	-9.520423	0.000000	0.978000	+	*
	STUDENT	103578.1	-9.864479	-9.863737	0.000000	0.025800	+	*
EGARCH	GAUSS	108568.4	-10.33986	-10.33924	1.000000	1.000000		*
	GED	120613	-11.48693	-11.48618	1.000000	1.000000		*
	STUDENT	121447.9	-11.56644	-11.5657	1.000000	1.000000		*
APARCH	GAUSS	109047.1	-10.38536	-10.38462	0.092300	0.011303	+	*
	GED	120807.9	-11.5054	-11.50453	0.079200	0.009863	+	*
	STUDENT	**121814.5**	**-11.60127**	**-11.6004**	**0.164000**	**0.998**	+	*
IGARCH	GAUSS	44829.5	-10.139442	-10.13862	1.000000	1.000000		
	GED	54467.681	-12.31886	-12.31722	1.000000	1.000000		
	STUDENT	48221.268	-10.90641	-10.90532	1.000000	1.000000		
FIGARCH	GAUSS	100132	-9.536195	-9.53533	0.999974	0.998800	+	
	GED	93484.983	-8.903184	-8.902443	0.997705	0.986500	+	*
	STUDENT	115118.494	-10.96361	-10.96287	1.000000	1.000000		

	GAUSS	76130.7	-7.250511	-7.250016	0.992649	0.960600	+	*
GAS	GED	76062.7	-7.243931	-7.243313	0.993646	0.964500	+	*
	STUDENT	93775.8	-8.930981	-8.930363	0.000000	0.0150000	+	*

IBOV

Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
	GAUSS	107485.7	-10.23684	-10.23635	0.318000	0.999900		*
GARCH	GED	120401.1	-11.46684	-11.46622	0.533000	0.999000		*
	STUDENT	121166.4	-11.53982	-11.53933	0.553000	0.999900		*
	GAUSS	107273.9	-10.21638	-10.21552	0.061100	0.006280		*
ACGARCH	GED	120406.8	-11.46719	-11.46633	0.100600	0.011286		*
	STUDENT	121160.8	-11.53901	-11.53814	0.110600	0.999		*
	GAUSS	108009.8	-10.28667	-10.28605	0.193000	0.999900		*
TARCH	**GED**	**120410.1**	**-11.46761**	**-11.46687**	**0.509000**	**0.999900**	+	*
	STUDENT	104669.1	-9.968394	-9.967652	0.000000	0.107400	+	*
	GAUSS	108176.8	-10.30256	-10.30194	1.000000	0.999900		*
EGARCH	GED	120611.5	-11.48679	-11.48605	1.000000	1.000000		*
	STUDENT	121464.9	-11.56807	-11.56733	1.000000	1.000000		*
	GAUSS	108641.6	-10.34674	-10.346	0.113100	0.011799		
APARCH	GED	120798.1	-11.50446	-11.50359	0.080700	0.009609	+	*
	STUDENT	121829.8	-11.60272	-11.60186	0.127800	0.010447	+	*
	GAUSS	48281.2	-10.919977	-10.918885	1.000000	1.000000	+	*
IGARCH	GED	54450.5	-12.315438	-12.314346	1.000000	1.000000		
	STUDENT	58150	-13.152013	-13.150648	1.000000	1.000000	+	*
	GAUSS	93297.5	-8.885421	-8.884803	0.996740	0.986200	+	
FIGARCH	GED	105282.679	-10.026828	-10.026086	1.000000	1.000000	+	*
	STUDENT	96682.3	-9.207703	-9.206961	0.999640	0.998400		
	GAUSS	75684.117	-7.207973	-7.207479	0.989523	0.951800	+	*
GAS	GED	75551.7	-7.195271	-7.194653	0.987874	0.947200	+	*
	STUDENT	93948.7	-8.947441	-8.946823	0.000000	0.078800	+	*

IPC

Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
	GAUSS	114751.1	-10.92882	-10.92832	0.006000	0.999900		*
GARCH	GED	132641.4	-12.63264	-12.63203	0.997000	1.000000		*
	STUDENT	**133770.4**	**-12.74017**	**-12.73955**	**0.998000**	**1.000000**	+	*
	GAUSS	114310.5	-10.88657	-10.88571	0.016400	0.001828		
ACGARCH	GED	132658.8	-12.63411	-12.63324	0.021700	0.002174	+	
	STUDENT	133925.5	-12.75475	-12.75389	0.024700	0.002422		
	GAUSS	114978.4	-10.95037	-10.94975	0.001000	1.000000		*
TARCH	GED	132646	-12.63298	-12.63224	0.997000	1.000000		*
	STUDENT	133770.9	-12.74012	-12.73938	0.998000	1.000000		*
	GAUSS	114741.7	-10.92783	-10.92721	1.000000	0.998000		*
EGARCH	GED	131474.5	-12.52141	-12.52067	1.000000	1.000000		*
	STUDENT	133583.8	-12.7223	-12.72156	1.000000	1.000000		*
	GAUSS	114978.6	-10.95029	-10.94955	0.062800	0.009036		*
APARCH	GED	132876.7	-12.65486	-12.65399	0.021200	0.002005		*
	STUDENT	134141.2	-12.77529	-12.77442	0.020300	0.001894		
	GAUSS	48514.5	-10.97274	-10.971648	1.000000	1.000000		
IGARCH	GED	58225.514	-13.169309	-13.168217	1.000000	1.000000		
	STUDENT	48514.5	-10.97274	-10.971648	1.000000	1.000000	+	*
	GAUSS	96261.6	-9.167728	-9.16711	0.991694	0.972000	+	
FIGARCH	GED	107187	-10.208156	-10.207415	1.000000	1.000000	+	*
	STUDENT	109122	-10.392472	-10.39173	1.000000	1.000000		
GAS	GAUSS	86209.617	-8.21045	-8.209955	0.999519	0.995500	+	*
	GED	84487.9	-8.04637	-8.045752	0.999993	0.999700	+	*

	STUDENT	86186.6	-8.208159	-8.207541	0.999914	0.995600	+	*

IPSA

Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	104310.1	-9.934391	-9.933897	0.159000	1.000000	+	*
	GED	132308.8	-12.60096	-12.60034	1.000000	1.000000		*
	STUDENT	132084.3	-12.57958	-12.57896	1.000000	1.000000		*
ACGARCH	GAUSS	104601.5	-9.961857	-9.960991	0.008700	0.000908		*
	GED	132602.6	-12.62875	-12.62789	0.008400	0.000857		*
	STUDENT	132082.9	-12.57925	-12.57839	0.015700	0.001566		
TARCH	GAUSS	106679.9	-10.16	-10.15938	0.298000	1.000000		*
	GED	132308.8	-12.60087	-12.60013	1.000000	1.000000		
	STUDENT	113818	-10.83975	-10.83901	0.164000	1.000000		
EGARCH	GAUSS	106957.6	-10.18644	-10.18583	1.000000	0.999900		*
	GED	131653.4	-12.53844	-12.5377	1.000000	1.000000		*
	STUDENT	**132348.9**	**-12.60468**	**-12.60394**	**1.000000**	**1.000000**		*
APARCH	GAUSS	107912.8	-10.27733	-10.27659	0.033100	0.005126		*
	GED	132561.8	-12.62487	-12.62401	0.076400	0.007189		*
	STUDENT	132785.9	-12.64621	-12.64535	0.055100	0.004480	+	
IGARCH	GAUSS	49429.3	-11.179676	-11.178584	1.000000	1.000000		
	GED	29885.552	-6.759229	-6.75841	0.076669	0.163800	+	
	STUDENT	49378.981	-11.168283	-11.168283	1.000000	1.000000	+	*
FIGARCH	GAUSS	92822.932	-8.840224	-8.839606	1.000000	1.000000	+	
	GED	95650.253	-9.10941	-9.108669	1.000000	1.000000	+	*
	STUDENT	120795	-11.504225	-11.503484	1.000000	1.000000	+	*
GAS	GAUSS	73829	-7.031291	-7.030796	0.999998	0.999900	+	*
	GED	73710.6	-7.019916	-7.019298	0.999999	0.999900	+	*
	STUDENT	128048	-12.195187	-12.194569	1.000000	1.000000	+	*

KOSPI

Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	108232	-10.30792	-10.30743	0.095000	1.000000		*
	GED	124622.5	-11.8689	-11.86828	1.000000	1.000000	+	*
	STUDENT	125363.7	-11.93949	-11.93887	0.991000	1.000000	+	*
ACGARCH	GAUSS	108155.6	-10.30035	-10.29949	0.017200	0.001833		*
	GED	124653	-11.87161	-11.87075	0.008109	0.008109		
	STUDENT	125400.4	-11.9428	-11.94194	0.099900	0.009536		
TARCH	GAUSS	108927.9	-10.37411	-10.37349	0.046000	1.000000		*
	GED	124632	-11.8697	-11.86896	0.991000	1.000000	+	*
	STUDENT	**125387.5**	**-11.94167**	**-11.94093**	**0.991000**	**1.000000**	+	*
EGARCH	GAUSS	108547.5	-10.33787	-10.33726	1.000000	0.954400		*
	GED	124672	-11.87352	-11.87278	1.000000	1.000000		*
	STUDENT	125551.7	-11.9573	-11.95656	1.000000	1.000000		*
APARCH	GAUSS	109081.7	-10.38866	-10.38792	0.101900	0.999		*
	GED	124789	-11.88456	-11.8837	0.164300	0.99999	+	*
	STUDENT	125974.7	-11.9975	-11.99663	0.052	0.003	+	*
IGARCH	GAUSS	48433.792	-10.954941	-10.954395	1.000000	1.000000		
	GED	53756.917	-12.158543	-12.157451	1.000000	1.000000	+	*
	STUDENT	48593.04	-10.990509	-10.989417	1.000000	1.000000		*
FIGARCH	GAUSS	94856.191	-9.033877	-9.033259	0.999829	0.998100	+	
	GED	107014.718	-10.191792	-10.19105	1.000000	1.000000	+	
	STUDENT	120299	-11.457033	-11.456292	1.000000	1.000000	+	
GAS	GAUSS	79725.822	-7.592916	-7.592422	0.999701	0.996400	+	*
	GED	79481.9	-7.56959	-7.568972	0.999696	0.996400	+	*
	STUDENT	109623	-10.44031	-10.439692	0.999994	0.999000	+	*

MERVAL								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	99598.76	-9.485667	-9.485172	0.000000	1.000000	+	*
	GED	117366.7	-11.17783	-11.17721	0.033000	1.000000	+	*
	STUDENT	118540.8	-11.28966	-11.28904	0.044000	1.000000	+	*
ACGARCH	GAUSS	100562	-9.577125	-9.576259	0.055000	0.003355		*
	GED	117368.2	-11.17779	-11.17692	0.054700	0.005406	+	
	STUDENT	118542	-11.28959	-11.28872	0.053700	0.005299	+	
TARCH	GAUSS	99673.35	-9.492676	-9.492057	0.000000	1.000000		*
	GED	117367.5	-11.17782	-11.17708	0.032000	1.000000	+	*
	STUDENT	118546.4	-11.2901	-11.28936	0.042000	1.000000	+	*
EGARCH	GAUSS	99730.59	-9.498128	-9.497509	1.000000	0.999900		*
	GED	117258.6	-11.16744	-11.1667	1.000000	1.000000		*
	STUDENT	118424.3	-11.27847	-11.27773	1.000000	0.996900		*
APARCH	GAUSS	100558.5	-9.57688	-9.576139	4.797400	0.8962		*
	GED	117481.9	-11.18862	-11.18776	0.046200	0.004109	+	
	STUDENT	118743.4	-11.30876	-11.3079	0.041900	0.003647	+	
IGARCH	GAUSS	40358.805	-9.128434	-9.127888	0.810101	1.000000	+	*
	GED	50769.4	11.482559	-11.48119	1.000000	1.000000	+	*
	STUDENT	43557.1	-9.85142	-9.850328	0.943597	1.000000	+	*
FIGARCH	GAUSS	99372.584	-9.46403	-9.463412	1.000000	1.000000	+	*
	GED	97975.524	-9.330875	-9.330134	1.000000	1.000000	+	
	STUDENT	**117314**	**-11.17271**	**-11.17271**	**1.000000**	**1.000000**	+	*
GAS	GAUSS	69413.588	-6.610752	-6.610752	0.989675	0.970500	+	*
	GED	69548.8	-6.623531	-6.622913	0.992339	0.976000	+	*
	STUDENT	87377.5	-8.321583	-8.320965	0.000040	0.000000	+	*

SPTSX								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	108817.4	-10.36367	-10.36318	0.002000	1.000000		*
	GED	135624.3	-12.91674	-12.91612	1.000000	1.000000		*
	STUDENT	137332.2	-13.07941	-13.07879	1.000000	1.000000	+	*
ACGARCH	GAUSS	108014	-10.28687	-10.286	0.016600	0.001548		*
	GED	135420.9	-12.89717	-12.89631	0.020200	0.002014		*
	STUDENT	137526.9	-13.09776	-13.09689	0.000700	0.000066		*
TARCH	GAUSS	109942.6	-10.47084	-10.47035	0.967000	1.000000		
	GED	135642.9	-12.91841	-12.91767	1.000000	1.000000	+	*
	STUDENT	**137351.4**	**-13.08114**	**-13.0804**	**1.000000**	**1.000000**	+	*
EGARCH	GAUSS	111771.2	-10.64491	-10.64429	1.000000	1.000000		*
	GED	135422	-12.89737	-12.89663	0.997000	1.000000		*
	STUDENT	116253.2	-11.07169	-11.07095	1.000000	0.994200		
APARCH	GAUSS	112898.8	-10.7522	-10.75146	0.018700	0.000832	+	
	GED	135969.9	-12.94946	-12.94859	0.008800	0.000859	+	*
	STUDENT	137898.9	-13.13319	-13.13232	0.001300	0.000126	+	*
IGARCH	GAUSS	46509.6	-10.51971	-10.519164	0.999604	0.984900		
	GED	62826.166	-14.209719	-14.208354	1.000000	1.000000		
	STUDENT	46134.037	-10.434299	-10.433207	1.000000	1.000000	+	*
FIGARCH	GAUSS	108605.477	-10.343395	-10.342777	1.000000	1.000000	+	*
	GED	100206.965	-9.543404	-9.542662	1.000000	1.000000	+	
	STUDENT	95573.9	-9.102141	-9.101399	0.999997	1.000000		*
GAS	GAUSS	78250.721	-7.452424	-7.451929	0.999967	0.999300	+	*
	GED	78152.7	-7.442992	-7.442374	0.999979	0.999500	+	*
	STUDENT	85310	-8.124672	-8.124054	0.999997	0.999400	+	*

SPX								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	107682.9	-10.25563	-10.25513	0.917000	1.000000		*
	GED	129595.6	-12.34265	-12.34215	0.998000	1.000000		*
	STUDENT	131162	-12.49174	-12.49112	0.998000	1.000000		*
ACGARCH	GAUSS	107385	-10.22696	-10.2261	0.058700	0.005652		*
	GED	129428.7	-12.32646	-12.3256	0.019600	0.001947		*
	STUDENT	131095.2	-12.48518	-12.48432	0.017000	0.001684		
TARCH	GAUSS	107702.1	-10.25736	-10.25674	0.877000	1.000000		*
	GED	129679.4	-12.35044	-12.3497	0.032000	1.000000		*
	STUDENT	131217.1	-12.49689	-12.49614	0.997000	1.000000		*
EGARCH	GAUSS	111107.3	-10.58168	-10.58106	1.000000	0.954100		*
	GED	129830.6	-12.36484	-12.3641	0.984000	1.000000		*
	STUDENT	131020.6	-12.47818	-12.47744	1.000000	1.000000		
APARCH	GAUSS	111174.8	-10.58801	-10.58727	0.028500	0.002364	+	*
	GED	130276.8	-12.40724	-12.40637	0.027800	0.002589	+	
	STUDENT	**132032.7**	**-12.57447**	**-12.57361**	**0.026700**	**0.002543**	+	*
IGARCH	GAUSS	45396.675	-10.267965	-10.267419	1.000000	1.000000		
	GED	58502	-13.231618	-13.230253	1.000000	1.000000		
	STUDENT	45716.172	-10.339781	-10.339781	1.000000	1.000000		*
FIGARCH	GAUSS	107008.157	-10.191262	-10.190644	1.000000	1.000000	+	*
	GED	104887.109	-9.989153	-9.988411	1.000000	1.000000	+	
	STUDENT	95365.4	-9.082283	-9.081542	0.999804	0.998800	+	*
GAS	GAUSS	77353.5	-7.366971	-7.366477	0.998779	0.992000	+	*
	GED	77270.8	-7.358996	-7.358378	0.999200	0.994000	+	*
	STUDENT	117718	-11.211307	-11.210689	1.000000	1.000000	+	*

UKX								
Modelo		LogL	AIC	HQ	Q (10)	ARCH(5)		
GARCH	GAUSS	107170.4	-10.20681	-10.20632	0.932000	1.000000	+	*
	GED	132066.3	-12.57787	-12.57725	1.000000	1.000000		*
	STUDENT	133389.9	-12.70392	-12.70331	0.993000	1.000000	+	*
ACGARCH	GAUSS	105993.2	-10.09441	-10.09354	0.013400	0.001349		*
	GED	132005.1	-12.57184	-12.57098	0.009900	0.000978		
	STUDENT	133577.7	-12.72163	-12.72076	0.007800	0.000770		
TARCH	GAUSS	107251.3	-10.21442	-10.2138	0.879000	1.000000		*
	GED	102886	-9.798559	-9.797817	0.961000	1.000000		*
	STUDENT	**133594.8**	**-12.72335**	**-12.72261**	**1.000000**	**1.000000**	+	*
EGARCH	GAUSS	106346.3	-10.12822	-10.1276	1.000000	1.000000		*
	GED	132481.3	-12.6173	-12.61656	0.995000	1.000000		*
	STUDENT	133573.8	-12.72135	-12.72061	1.000000	1.000000		*
APARCH	GAUSS	108603.4	-10.3431	-10.34236	0.001398	0.013200	+	*
	GED	132675.6	-12.6357	-12.63484	0.004200	0.000419	+	
	STUDENT	134518	-12.81118	-12.81032	0.003400	0.000335	+	*
IGARCH	GAUSS	40704.2	-9.206566	-9.20602	1.000000	1.000000	+	*
	GED	58771.098	-13.29249	-13.291125	1.000000	1.000000	+	*
	STUDENT	44089.5	-9.97183	-9.97183	1.000000	1.000000		*
FIGARCH	GAUSS	100604.104	-9.581323	-9.580705	1.000000	1.000000	+	
	GED	96077.9	-9.150137	-9.149395	1.000000	1.000000	+	
	STUDENT	95716.24	-9.115695	-9.115695	1.000000	1.000000	+	*
GAS	GAUSS	76210.8	-7.25814	-7.25814	0.999985	0.999500	+	*
	GED	76137.8	-7.251084	-7.250466	0.999987	0.999600	+	*
	STUDENT	129107	-12.296044	-12.295426	1.000000	1.000000	+	*