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Foreign exchange market and contagion: The evidence through GARCH model

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ABSTRACT: The goal of this study is to measure contagion phenomenon between foreign exchange markets during Subprime crisis & Eurozone crisis using daily data from 03/01/2005 to 02/01/2014 for fourteen selected countries namely Algeria, Argentina, Australia, china, India, Iceland, Great Britain, Malaysia, Nigeria, New-Zealand, Norway, Mexico, the Philippines and Russia via GARCH (1,1), GJR-GARCH(1,1), EGARCH(1,1), APARCH(1,1) models.

In our analysis, we will have discriminated between independent floaters and managed floaters exchange rate. We also separated the period estimate in two period's crises. Firstly, the US Subprime crisis period covers from 17/07/2007 through 31/08/2009 (See Dungey, 2009, Celik, 2012). Secondly, the period of the Euro-zone crisis that we have covered from 19.11.2009 to 31.12.2012 (See Wasim. A et all 2013).

In summary, we concluded of all exchange rates returns series influenced by the contagion effects come from USA and euro area over 2007-2012 periods. In addition to that, we documented that persistence volatility have been high shock in the countries adopting independent floating exchange rates compare the countries they supported managed floaters.

KEYWORDS: contagion, subprime and Eurozone crises, GARCH model, Exchange Rate Regimes.

JEL CLASSIFICATIONS: F31, G01, G15.

1 INTRODUCTION

In the past recent years, particularly After July 2007, the global economy has been living the worst financial crisis since the Great Depression of the 1930s, so, it led to decline macroeconomic variables as recession, slower GDP growth and other consequences effects as unemployment rates, inflation, National and Multinational institutions collapse, stock markets crashes ……

In addition, Suffer in the world economy doesn't stop from The U.S. Subprime mortgage crisis, while, it's followed by Eurozone crisis (2010-May 2013). It has sizeable effects not only of the euro area member states' economies, but in several markets around the world.

Contagion phenomenon during Subprime crisis and Eurozone crisis is not limited to transmit shocks on the macroeconomic and stock markets fundamentals, but it considerate contagion phenomenon in the Foreign exchange market**,** while led rapidly to massive declines of the major currency see **Figure 1….**

The goal of this study is to try and measure contagion phenomenon between foreign exchange markets during The U.S. subprime mortgage and Eurozone crises through an empirical analysis using GARCH methodology upon daily data from 03/01/2005 to 02/01/2014 for 14 countries 2003-2013. But Before illustrating this aim of our results, we shall discriminate

between independent floaters and managed floaters exchange rate for appearing the best exchange rate system performance over 2005-2014 period.

The rest of the paper is organized as follows. In section 2 we present a Literature Review on Contagion phenomenon; Section 3 presents the Model and the Methodology, followed by the results and discussion showed in Section 4, and finally, Section 5 presents the main conclusion.

2 LITERATURE REVIEW

The currency markets are the larger an asset market size. The trading in foreign exchange markets is averaged $5.3 trillion per day in April 2013 compared by $3.3 trillion in April 2007 **(Bank for International Settlements, 2013).** Moreover, the exchange rate volatility does increase more than proportionally with the global financial stress, when, evidence regional contagion effects is spread **(Virginie Coudert et all, 2011)**.

Several studies are classified the exchange rates regimes for capturing currencies vulnerability during crisis periods. Jean-Louis Combes (2012) rejected that intermediate regimes are more vulnerable to crises compared to the hard peg and the fully floating regimes. **Atish R. Ghosh (2010)** suggested that the growth performance for pegs was not different from that of floats during the crisis. For the recovery period 2010–11, pegs appear to be faring worse.

In the crises history during two last decades, the fixed exchange rate regimes are more vulnerable and fragile when the crisis occurrence*:* the Mexican peso crisis (1994), The Asian financial crisis (1997), the Russian and Brazilian financial crises (1998, 1999), the devaluation of the Argentina peso (2002); **(see, Jean-Louis Combes (2012), Ahmed Atil (2008) , Levy-Yeyati et al. (2006), Fischer (2001))**

Van Horen et all (2006) investigated whether the contagion has transmit from Thailand to the other crisis countries through the foreign exchange market during the Asian crisis. Results show that there is evidence of contagion from Thailand with 13% and 21 % respectively to Indonesia and Malaysia currencies attributable to that contagion. On the Contrary, for Korea and the Philippines there is no evidence of contagion from Thailand.

Eichengreen et al. (1996) used thirty years of panel data from twenty industrialized countries for finding that is spread more easily contagion currency crises among the countries which are closely tied by international trade linkages. they paper propose inspired for late research to estimate similar approach and find that trade linkages are important evidence h on the contagion transmission in geographic proximity. (See **Eichengreen and Rose (1998), Tornell and Velasco (1996) Huh and Kasa (1997); Rigobon (1998))**

Glick and Rose (1999) provide to five episodes of currency (in 1971, 1973, 1992, 1994, and 1997) and 161 countries that trade linkages help explain cross-country correlations in exchange market pressure during crisis episodes. **Celik (2012)** found strong evidence of contagion across foreign exchange markets on 10 emerging and 9 developed markets for the period 2005–2009 using DCC-GARCH model.

In contrast, many studies have highlighted of contagion evidence are not propagated when existed linked directly by macroeconomic fundamentals as Trade links (**Eichengreen et al. (1996),** or common shocks and Financial links (**Calvo (1999), Forbes and Rigobon , (2001) Rijckeghem and Weder, 2001)** …. but just to transmit when there are down on Stock Markets (Directly) during the financial crisis **(Bouaziz et al., 2012, Flavin and Panopoulou, 2010, Hutchison 2009, Khan andPark, 2009; Cho and Parhizgari, 2008…..)**

Aloui et all (2011) showed out in their study strong evidence of time-varying correlation and persistence between stock markets of each of the BRIC (Brazil, Russia, India, China) and the US markets Using daily return data for the period 2004 to 2009.

Dajcman et al. (2012) applied a Dynamic Conditional Correlation-Generalized Autoregressive Conditional Heteroskedastic (DCC-GARCH) on a daily return series for the period 1997 to 2010 for examine the co-movement dynamics across the stock markets of U.K., Germany, France, and Austria. **Kazi et al. (2013)** finds on the same model in sixteen OECD countries' stock markets for detecting same results while, that consist the co-movement dynamics between those markets and found a significant evidence of contagion effects after the GFC. **Hwang et al. (2010)** used a DCC-GARCH model on 38 country data. He found evidence of financial contagion not only in emerging markets but also in developed markets during U.S. subprime.

The study of **Naoui et al. (2010)** examined financial contagion using the DCC GARCH (1,1) technique and a correlation test for 10 emerging markets from 1 January 2005 to 01 July 2010. Their results indicate a contagion effect from the US towards Argentina, Brazil, Korea, Honk-Kong, Malaysia, Mexico and Singapore except for the Shanghai market (China) during the subprime crisis. **Yiu, Ho and Choi, (2010)** examined the dynamics of correlation between 11 Asian stock markets and the

US stock market from 1993 to early 2009 within asymmetric DCC-GARCH model. Their study finds strong evidence of contagion from USA to Asian markets in the period from late of 2007, while, they found no such evidence of having contagion between markets in Asia during the Asian financial crisis. **Aka (2009)** investigated the transmission of the contagion from the US stock market to the West African Regional Stock Market (BRVM) from January 2, 2007, through January 30, 2009. it finds that contagion effects in the mean and volatility from the US market to the BRV. **Khallouli. W and Sandretto. R, (2012)** carried out a similar analysis for the Middle East and North African countries (MENA) and they provide the evidence of mean and volatility contagion in MENA stock markets caused by the US stock market.

3 MODEL AND METHODOLOGY

3.1 DATA SOURCE

In our analysis we try to examine contagion phenomenon among foreign exchange markets during Subprime crisis and Eurozone crisis using daily data from 03/01/2005 to 02/01/2014 for fourteen selected countries representing American, European, Middle East, Oceania, Asian and African countries.

For seven countries followed floating exchange markets namely Australia, Great Britain, Iceland, New-Zealand, Norway, Mexico, the Philippines and sven countries followed managed float rate regimes namely Algeria, Argentina, china, India, Nigeria, Malaysia, and Russia. We use euro/US dollar exchange rate as a proxy for exchange rate variation across to Subprime crisis & Eurozone crisis. The sources of these exchange rates are collected from Thomson Reuters DataStream. The return on exchange rate is defined as:

We calculate foreign exchange rate returns as:

$$R_{it} = \ln(\frac{T_{it}}{T_{t-1}}) \text{..... (1)}$$

Where:

T_{it}: Foreign exchange rate at time t

T_{t-1}: Foreign exchange rate at time t-1

R_{it}: Return on exchange rate at time t

3.2 DEFINITION OF THE GARCH MODEL

In this study, the model we used is a **generalized autoregressive conditional heteroskedasticity** (**GARCH**, while, Bollerslev (1986)) suggested the generalized ARCH of Engle (1982)

. The GARCH model considers conditional variance to be a linear combination between squired of residual and a part of lag of conditional variance.

The mathematical representation of a GARCH (p, q):

$$h_t = a + \sum_{i=1}^{q} b_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} c_j h_{t-j}^2 \qquad (2)$$

$$\text{Where } a > 0, b_i \geq 0\ , c_j \geq 0 \forall \text{ i, } \forall \text{ j}$$

Where a a variance in long term is, $\sum_{i=1}^{q} b_i \varepsilon_{t-i}^2$ is squired of residual and $\sum_{j=1}^{p} c_j h_{t-j}^2$is a lag of conditional variance. In this context, we can be applied others models of asymmetric volatility to test the existence of contagion during Global Financial Crisis as the exponential GARCH (EGARCH) model, Glosten, Jogannathan, and Rankle (1992) GJR-GARCH model, asymmetric power ARCH (APARCH), Zakoian (1994) threshold ARCH (TARCH) see more Olowe, Rufus Ayodeji (2009).

4 RESULTS AND COMMENT

4.1 DESCRIPTIVE STATISTICS OF FOREIGN EXCHANGE RATE RETURNS

In this section, we shall separate the period estimate in tree periods. Firstly, US Subprime crisis period covers from 17/07/2007 through 31/08/2009 **(See Dungey, 2009, Glik, 2012)**. Firstly, the US Subprime crisis period covers from

17/07/2007 through 31/08/2009 **(See Dungey, 2009, Glik, 2012)**. Secondly, the period of the Euro-zone crisis that we have covered from 19.11.2009 to 31.12.2012 **(See Wasim. A et all 2013)**.

4.2 DESCRIPTIVE STATISTICS

Table 1 and 2 show descriptive statistics of floaters and managed floaters exchange rate returns respectively from17.07.2007 to 31.08.2009 (financial Crisis)

The mean returns for all series are close to zero. We observe the kurtosis coefficients of the foreign exchange rate returns in the first arrangement are a lower to secondly regime, (with a kurtosis value> 3). In the first hand, these results explain the big shocks in two foreign exchange rate markets, on the other hand, this result reveal with their central banks intervening in forex market to defend their currencies (managed float rate exchange regime) to stabilize the situation over crisis period within monetary policy targets. The skewness coefficients were different than zero, while, it is indicates a non-symmetric series. The Jarque-Bera test and for normality for all the currencies in Table 1 and 2 are significant, which mean the exchange returns are not normal distribution.

In Table 3 and 4, reports descriptive statistics of independently floating and managed float rate exchange rate returns respectively from 19.11.2009 to 31.12.2012 (Eurozone crisis), the kurtosis coefficients were greater than three of all series, Jarque– Bera (JB) test indicates non–normality of most of the foreign exchange rate returns.

Entire period results presented in table 4 and 5 shows their kurtosis of the exchange rate returns exceed 3, while, the skewness (positive or negative) and Jarque– Bera results rejects the null hypothesis and indicates non- normal distribution of series. Finally, the mean of the log exchange rate returns range from to zero.

4.3 ESTIMATION RESULTS OF GARCH (1, 1) MODEL

Before illustrating the results of generalized autoregressive conditional heteroscedasticity (GARCH) models, it is necessary to examine Heteroscedasticity test. The ARCH LM test proposed by **Engle (1982)** indicates the presence of ARCH effects of all foreign exchange markets returns residuals **(See figure 02).**

In the secondly examine, we make evaluates using tests of the **Akaike information criterion (AIC), (1974, 1976), Hannan-Quinn criter (HQC), (1979) and Schwarz Criterion, (SC), (1978)** for detecting the best models between ARCH family models was selected (GARCH (1,1), GJR-GARCH(1,1), EGARCH(1,1), APARCH(1,1) models). The GARCH (1, 1) appears more advantages which has a less values in formers tests most equations estimating.

In table 7, 8, 9,10,11,12, the results of parameter estimates using GARCH (1, 1) model are significant at 5% significance level**.** In particularly, the estimate y_1 parameter is positive on all currencies and for each period. This finding is reveal the role of the US dollar rates with exogenously determined to effect transmits on the other foreign exchange rates.

We also note in those tables high persistence of shocks in the volatility on all currencies (ARCH term α + GARCH term β are statistically significant at the 1%). Therefore and Based on same model, the results show when we datable

Independently floating and managed float rate regimes that persistence volatility have been high shock in the countries adopting first regime compare the countries they supported independently floating exchange rates. The sum of the estimated persistence volatility (α and β parameters) are exceed than one for Great Britain, Iceland and Mexico during financial crisis period. in the cases of Australia, N-Zealand, Norway and the Philippines, the sum of the two estimated ARCH and GARCH coefficients is very close to one which indicating that volatility shocks are quite persistent in the first group compare to second's. In same table and in all countries followed managed float rate regime, results show that the sum of persistence volatility are significant and it appear very high the sum of the estimated persistent coefficients very high but less than one except India exchange rate.

In contrast and during Eurozone crisis, the seven independently floating exchange rate the sum of the volatilities persistence's around than one. In same period and for almost all countries followed other regime are the sum of the volatilities persistence's are less than 1.this results of the two regimes reveals the stability exchange rate volatility for each period. In summary, we concluded of all exchange rates returns series influenced by the contagion effects come from USA and euro area over 2007-2012 periods.

5 CONCLUSION

In this paper, we measure contagion phenomenon between foreign exchange markets during Subprime crisis & Eurozone crisis using daily data from 03/01/2005 to 02/01/2014 for fourteen countries used different regimes exchange rate by employing GARCH (1.1) model.

The main finding showed in Table 7 to 12 indicates that volatility persistence is higher in the independently floating exchange rate than manager's exchange regime and same results appear the US Subprime crisis are more contagion than Eurozone crisis.

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ANNEX

Figure 1: foreign exchange rates

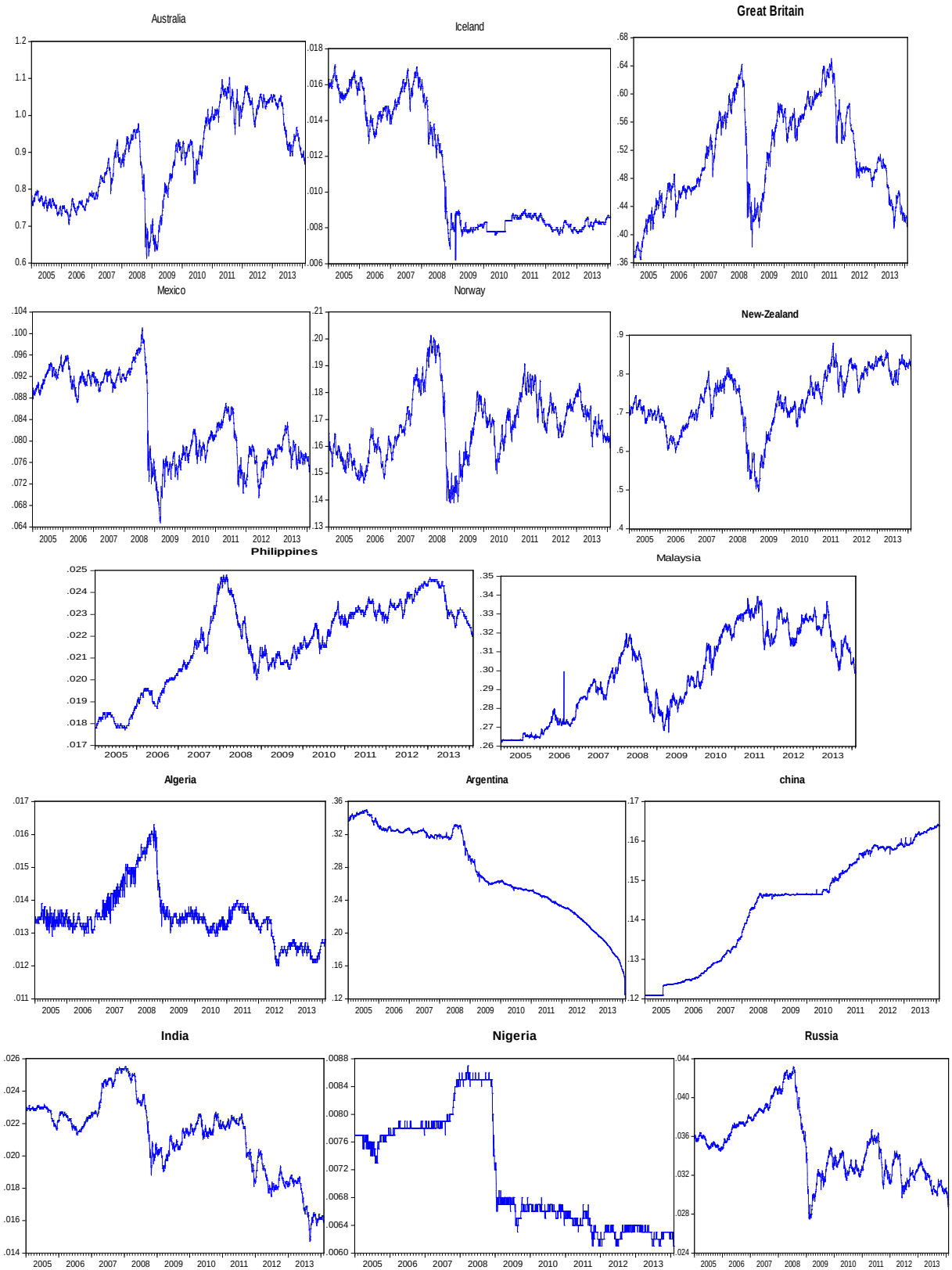


Table 01: descriptive statistics of independently floating exchange regimes from 17.07.2007 to 31.08.2009 (financial Crisis)

	Australia	Great Britain	the Philippines	Iceland	Mexico	Norway	N-Zealand
Mean	0.0000	-0.0003	-0.0001	-0.0009	-0.0003	-0.0001	-0.0002
Maximum	0.053	0.031	0.018	0.362	0.039	0.042	0.047
Minimum	-0.061	-0.040	-0.019	-0.350	-0.089	-0.045	-0.047
Std. Dev.	0.010	0.006	0.004	0.027	0.008	0.008	0.009
Skewness	-0.390	-0.732	-0.165	-1.254	-2.472	-0.251	-0.378
Kurtosis	10	10	4	117	31	8	7.34
Jarque-Bera	1731	1771	59	420336	26742.	723.	628.
Observations	777	777	777	777	777	777	777

Table 02: descriptive statistics of managed float rate regimes from 17.07.2007 to 31.08.2009 (financial Crisis)

	Algeria	Argentina	china	India	Malaysia	Nigeria	Russia
Mean	-0.0001	-0.0003	0.0001	-0.0003	0.0000	-0.0003	-0.0003
Maximum	0.042	0.035	0.007	0.032	0.031	0.040	0.031
Minimum	-0.046	-0.026	-0.008	-0.025	-0.026	-0.031	-0.043
Std. Dev.	0.010	0.004	0.001	0.005	0.004	0.007	0.006
Skewness	-0.085	0.724	-0.142	0.566	0.183	-0.202	-1.245
Kurtosis	8.291	22.564	17.142	9.587	9.388	7.415	15.005
Jarque-Bera	907	12459	6477	1446	1325	636	4867
Observations	777	777	777	777	777	777	777

Table 03: descriptive statistics of independently floating exchange regimes from 19.11.2009 to 31.12.2012 (Eurozone crisis)

	Australia	Great Britain	the Philippines	Iceland	Mexico	Norway	N-Zealand
Mean	0.0002	-0.0001	0.0001	0.0000	0.0000	0.0000	0.0001
Maximum	0.024	0.012	0.022	0.074	0.028	0.019	0.022
Minimum	-0.032	-0.018	-0.014	-0.062	-0.035	-0.023	-0.037
Std. Dev.	0.006	0.004	0.004	0.006	0.005	0.006	0.006
Skewness	-0.400	-0.303	0.041	0.848	-0.581	-0.406	-0.442
Kurtosis	5.252	4.329	5.099	50.314	8.901	4.220	5.283
Jarque-Bera	191	72	148	75091	1212	72	201
Observations	804	804	804	804	804	804	804

Table 04: descriptive statistics of managed float rate regimes from 19.11.2009 to 31.12.2012 (Eurozone crisis)

	Algeria	Argentina	china	India	Malaysia	Nigeria	Russia
Mean	0.0000	-0.0002	0.0001	-0.0001	0.0001	-0.0001	-0.0001
Maximum	0.030	0.011	0.008	0.023	0.025	0.031	0.027
Minimum	-0.030	-0.011	-0.008	-0.025	-0.017	-0.030	-0.029
Std. Dev.	0.007	0.002	0.001	0.005	0.004	0.007	0.005
Skewness	-0.050	0.055	0.039	-0.319	0.369	-0.009	-0.323
Kurtosis	6.420	8.053	15.024	6.657	7.880	5.329	6.454
Jarque-Bera	392	856	4844	462	816	182	414
Observations	804	804	804	804	804	804	804

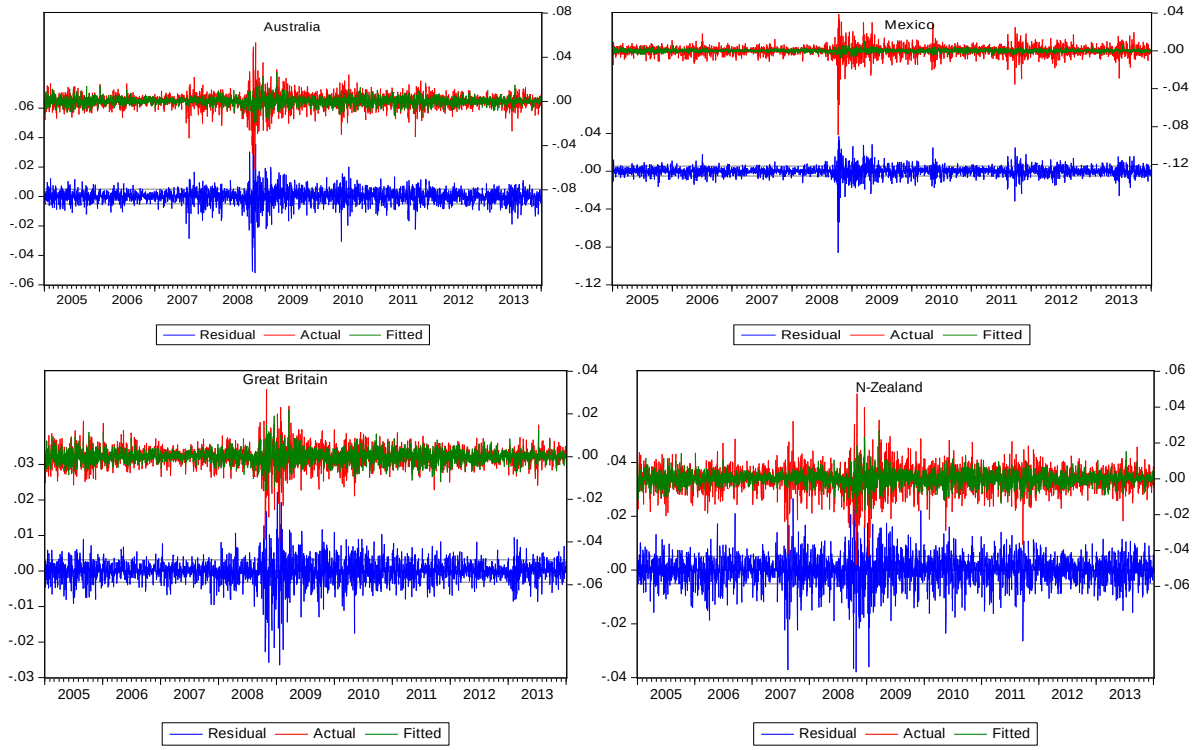
Table 05: descriptive statistics of independently floating exchange regimes from 03.1.2005 to 02.1.2014 (Entire period)

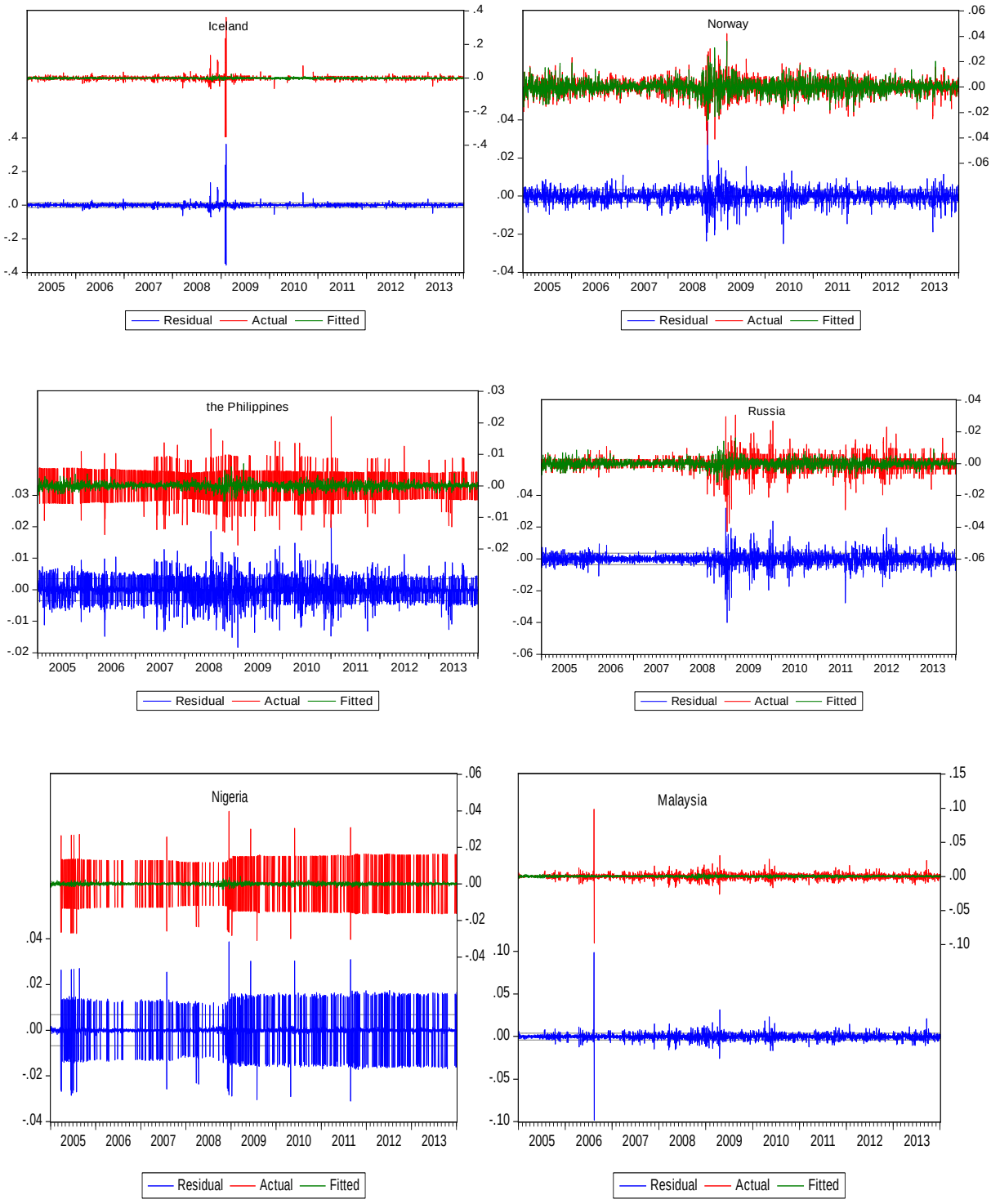
	Australia	Great Britain	the Philippines	Iceland	Mexico	Norway	N-Zealand
Mean	0.00004	-0.00005	0.00007	-0.00019	-0.00005	0.00000	0.00004
Max	0.053	0.031	0.022	0.362	0.039	0.042	0.047
Min	-0.061	-0.040	-0.019	-0.350	-0.089	-0.045	-0.048
Std. Dev.	0.006	0.004	0.004	0.014	0.005	0.006	0.006
Skewness	-0.458	-0.603	-0.107	-2.176	-1.979	-0.304	-0.448
Kurtosis	14.567	11.952	5.356	366.466	35.246	8.247	8.948
Jarque-Bera	18450	11182.	767	18106817	144640.	3823.	4957.
Observations	3287	3287	3287	3287	3287	3287	3287

Table 06: descriptive statistics of managed float rate regimes from 03.1.2005 to 02.1.2014 (Entire period)

	Algeria	Argentina	china	India	Malaysia	Nigeria	Russia
Mean	-0.00002	-0.00024	0.00009	-0.00011	0.00004	-0.00006	-0.00005
Max	0.065	0.035	0.020	0.032	0.098	0.040	0.031
Min	-0.046	-0.026	-0.010	-0.027	-0.098	-0.031	-0.043
Std. Dev.	0.009	0.002	0.001	0.005	0.004	0.007	0.004
Skewness	0.072	0.519	2.307	0.032	0.242	-0.093	-0.751
Kurtosis	9.986	31.077	72.430	8.624	198.670	6.470	14.011
Jarque-Bera	6691	108180	663526	4334	5246929	1655	16926
Observations	3287	3287	3287	3287	3287	3287	3287

Figure 02 : Arch effets

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Malaysia
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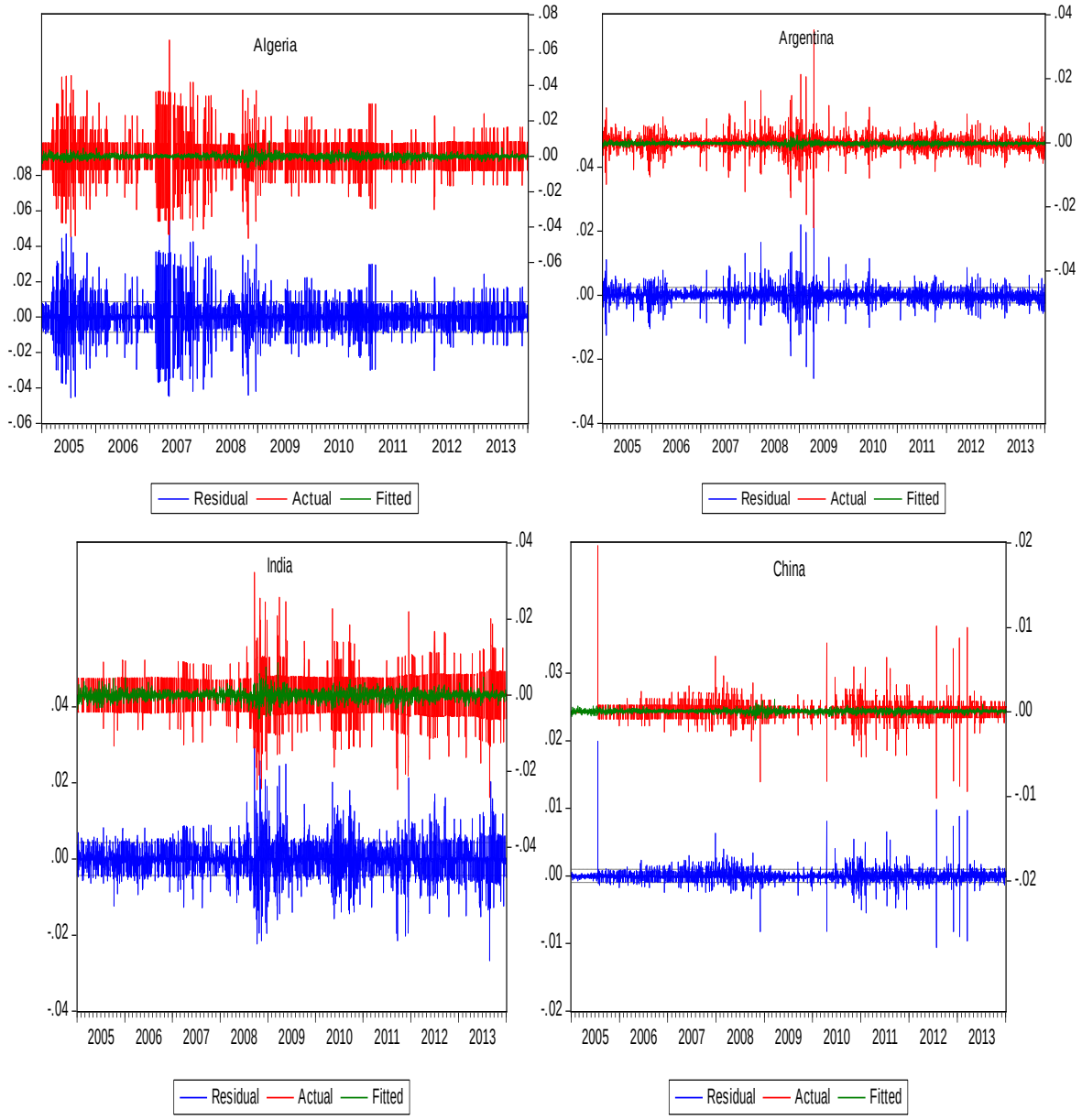


Table 7: Parameter Estimates for GARCH Model for independently float rate regimes from 17/07/2007 31/08/2009

Parameter	γ_0	γ_1	a	b	Persistance
Australia	8.97E-05*	0.969543*	0.124486*	0.833688*	0.958174
Great Britain	-0.00025	0.678107*	0.065186*	0.929636*	0.994822
Iceland	-0.001281	1.113158*	0.660635*	0.572185*	1.23282
N-Zealand	-0.000126*	1.008644*	0.079832*	0.890858*	0.97069
Mexico	0.000157	0.14541*	0.13243*	0.866455*	0.998885
Norway	0.000156	1.154827*	0.193152*	0.798383*	0.991535
Philippine	-0.000142*	0.223777*	0.015127*	0.976955*	0.992082

Table 8: Parameter Estimates for GARCH Model for managed float rate regimes from 19/11/2009 31/12/2012

Parameter	γ_0	γ_1	a	b	Persistance
Australie	0.000481*	0.78269*	0.105246*	0.798701*	0.903947
Great Britain	-1.73E-05	0.51133*	-0.008373*	1.001391*	0.993018
Iceland	0.000469*	0.360438*	-0.006615*	0.884087*	0.877472
N-Zealand	0.00053	0.79912*	0.194746*	0.080154*	0.2749
Mexico	0.000374*	0.446849*	0.200394*	0.760245*	0.960639
Norway	0.000297	1.017111*	0.426768*	-0.036841*	0.389927
Philippines	0.000196*	0.221827*	0.083896*	0.846249*	0.930145

Table 9: Parameter Estimates for GARCH Model for Independently float rate regimes from 17/07/2007 31/08/2009

Parameter	γ_0	γ_1	a	b	Persistance
Russia	1.86E-05	0.552558*	0.081106*	0.925979*	1.007085
Algeria	-0.000189	0.301162*	0.137718*	0.819069*	0.956787
Nigeria	0.000116	0.101552*	0.149936*	0.806468*	0.956404
Malaysia	1.12E-05	0.328576*	0.136888*	0.82636*	0.963248
India	-0.000134*	0.228683*	0.09067*	0.906474*	0.997144
chaina	0.000122	0.045964*	-0.011165*	0.579763*	0.568598
Argentina	-4.33E-05	0.067612*	0.408902*	0.594285*	1.003187

Table 10: Parameter Estimates for GARCH Model for managed float rate regimes from 19/11/2009 31/12/2012

Parameter	γ_0	γ_1	a	b	Persistance
Russia	0.000182*	0.534752*	0.189285*	0.768163*	0.957448
Algeria	-9.89E-06	0.245703*	0.195526*	0.678793*	0.874319
Nigeria	-6.73E-05	0.076194*	0.211149*	0.364486*	0.575635
Malaysia	0.000224*	0.324389*	0.05429*	0.90555*	0.95984
India	0.000101*	0.32593*	0.096907*	0.878541*	0.975448
chaina	8.82E-05	0.047245*	0.268823*	0.523848*	0.792671
Argentina	-0.00019	0.10003*	0.232885*	0.707651*	0.940536

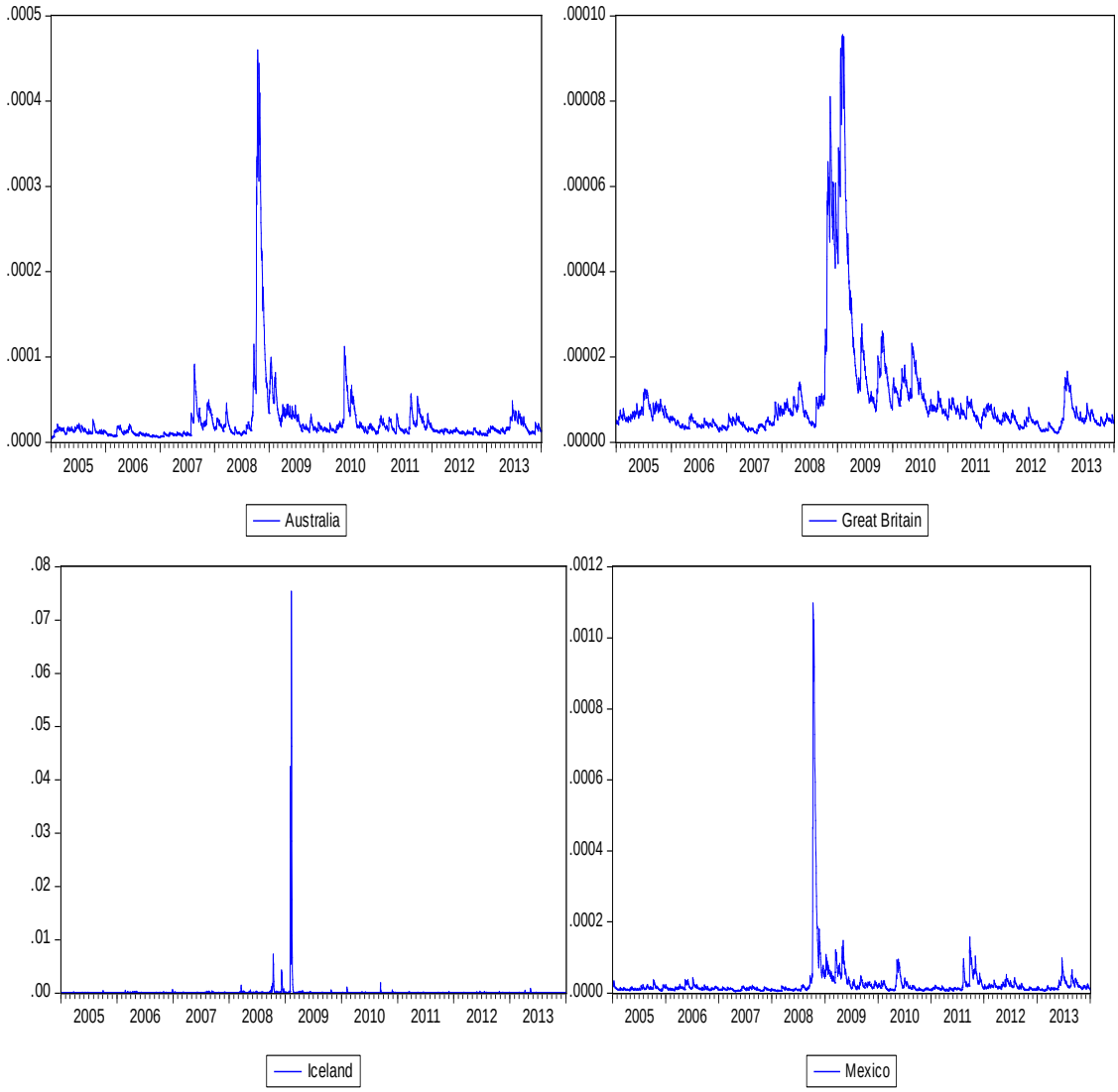
Table 11: Parameter Estimates for GARCH Model for Independently float rate regimes from 1/01/2005 1/02/2014

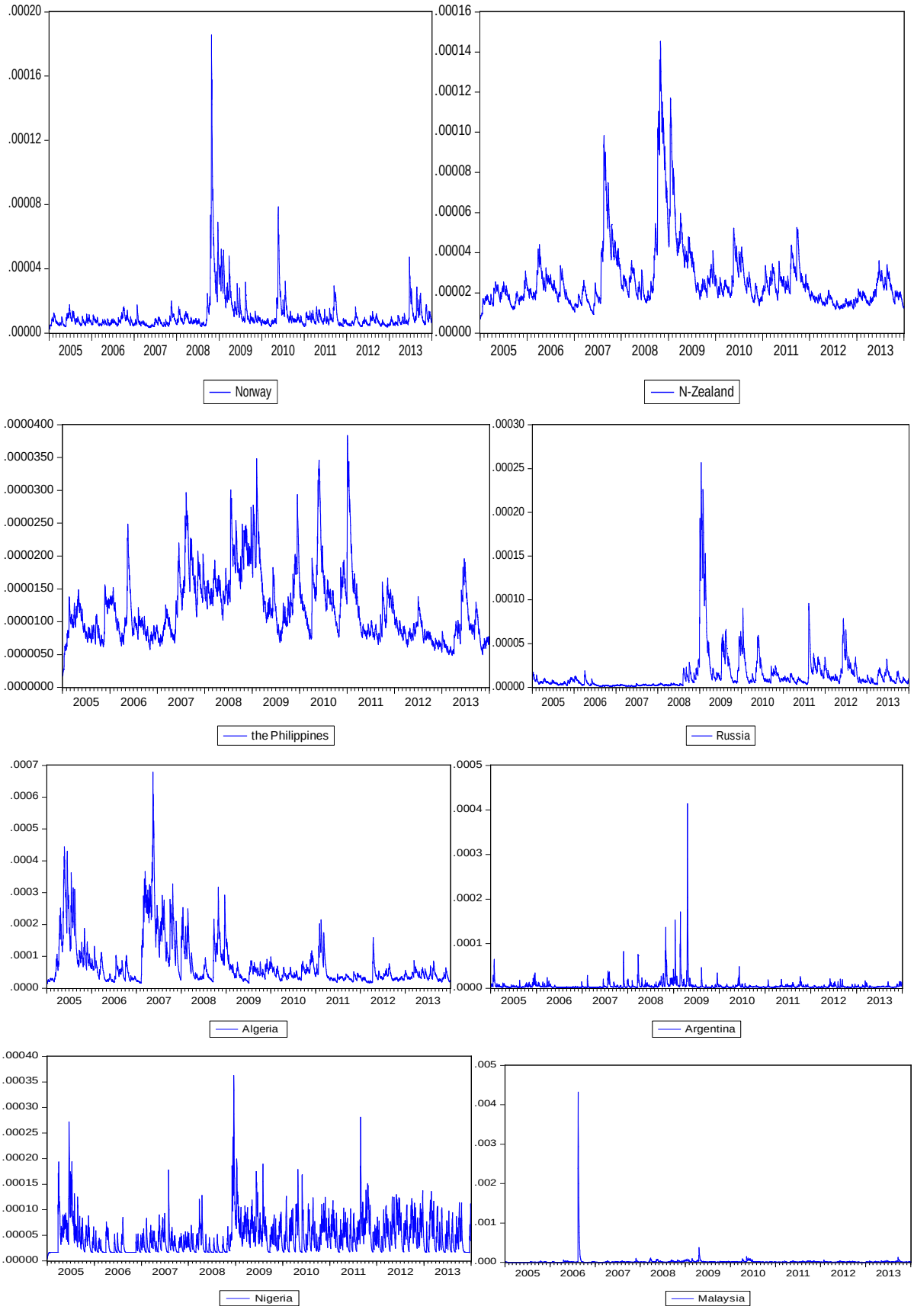
Parameter	γ_0	γ_1	a	b	Persistance
Australia	0.0000933	0.745604*	0.059159*	0.928003*	0.987162
Great Britain	0.000177	0.633037*	0.042441*	0.952221*	0.994662
Iceland	-0.000268	0.668543*	0.16874*	0.816874*	0.985614
Mexico	0.000127*	0.29982	0.093071*	0.889503*	0.982574
Norway	0.000632*	1.040295*	0.076505*	0.894843*	0.971348
N-Zealand	0.0000932	0.778014*	0.034932*	0.954436*	0.989368
Norway	0.0000632	1.040295*	0.076505*	0.894843*	0.971348
the Philippines	0.0000827	0.200708*	0.039043*	.947375*	0.986418

Table 12: Parameter Estimates for GARCH Model for managed float rate regimes from 1/01/2005 1/02/2014

Parameter	γ_0	γ_1	a	b	Persistance
Russia	0.0000661*	0.466395*	0.090915*	0.91208*	1.002995
Algeria	-7.51E-05	0.249473*	0.070244*	0.916539*	0.986783
Nigeria	5.10E-05	0.115169*	0.137492*	0.802299*	0.939791
Malaysia	0.0002	0.17892*	0.245152*	0.82376*	1.068912
India	-2.36E-05	0.245481*	0.06709*	0.92233*	0.98942
chaina	1.05E-04	0.040035*	0.222034*	0.2057*	0.427734
Argentina	-1.76E-04	0.085796*	0.246103*	0.69729*	0.943393

Figure 03: Conditional Variance

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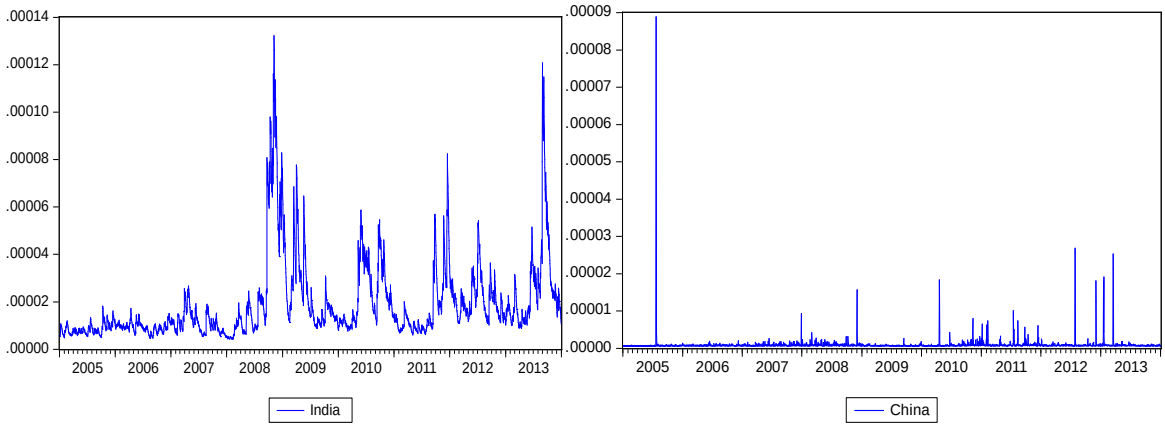
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