Dynamic conditional correlation analysis of foreign exchange market contagion during subprime crisis

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ABSTRACT

The objective of this study is to measure contagion phenomenon between foreign exchange markets during Subprime crisis using daily data from 03/01/2005 to 02/01/2014for ten selected countries namely Algeria, Argentina, Australia, china, India, Great Britain, Malaysia, New-Zealand, Norwayand Russiavia Dynamic conditional correlation multivariate GARCH. In summary, we concluded of all exchange rates returns series influenced by the contagion effects come from USA. Moreover, we observed the mean Dynamic conditional correlation multivariate *GARCH* increase in financial compared the pre-crisis period.

Keyword: *contagion, subprime crisis, DCC-MGARCH model, Exchange Rate Regimes.*

JEL classifications: **F31, G01,G15**

I. 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 crisisis 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 trying to measure the contagion phenomenon between foreign exchange markets during The U.S. subprime mortgage through an empirical analysis using DCC MGARCH methodology upon daily data from 03/01/2005 to 02/01/2014 for 10 countries2003-2013.

The rest of the paper 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.

II. Literature Review

The currency marketsare 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 **(VirginieCoudertet 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 etal (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.

Eichengreenet 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 transmissionin 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 **(Jawadi*etal.*(2014), Bouaziz et al., 2012, Flavin and Panopoulou, 2010, Hutchison 2009, Khan andPark, 2009; Cho and Parhizgari, 2008…..)**

Alouietall (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 period2004 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.

III. Model and Methodology

1. Data source

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

We use euro/US dollar exchange rate as a proxy for exchange rate variation across to Subprime crisis. The sources of these exchange rates collected from Thomson Reuters Data Stream. The return on exchange rate 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 rateat time t

T_{t-1}: Foreign exchange rateat timet-1

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

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 residualand$\sum_{j=1}^{p} c_j h_{t-j}^2$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).

The development of the multivariate GARCH modelis designed to make GARCH models more parsimonious.WeidentifytheConstantConditionalCorrelation-(CCC)-GARCH model (Bollerslev,1990), the BEKK-GARCH model(EngleandKroner,1995),and the Dynamic (D)CC-GARCH model (EngleandSheppard,2001).

Results and Comment

1. **Descriptive statistics of foreign exchange rate returns**

The US Subprime crisis period covers from 17/07/2007 through 31/08/2009 **(See Dungey, 2009, Glik, 2012)**.

Table one show descriptive statistics of exchange rate returns 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 are a lower, (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 are significant, which mean the exchange returns are not normal distribution.

Entire period results presented in table 2 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.

2. **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 3 and 4the results of parameter estimates using GARCH (1, 1) model are significant at 5% significance level**.** In particularly, the estimate $y_1$parameteris positive on all currencies and for each period. This findings 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

The sum of the estimated persistence volatility (α and β parameters) are exceed than one for Great Britain, during financial crisis period. In addition, in the cases of Australia, N-Zealand and Norway, the sum of the two estimated ARCH and GARCH coefficients is very close to one. 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 summary, we concluded of all exchange rates returns series influenced by the contagion effects come from USA.

For checking, table 5, 6shows the mean Dynamic conditional correlation multivariate GARCH during pre-crisis and crises. It indicates significant correlation over time, accordingly, we observed the mean Dynamic conditional correlation multivariate *GARCH* increase in financial with large and speed transmission compared the pre-crisis period.

Conclusion

In this paper, we measure contagion phenomenon between foreign exchange markets during Subprime crisisusing daily data from 03/01/2005 to 02/01/2014 for ten countries used different regimes exchange rate by employing DCC MGARCH 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 the mean Dynamic conditional correlation multivariate GARCH increase in financial crisis compared the pre-crisis period.

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Annex

Figure 1: foreign exchange rates

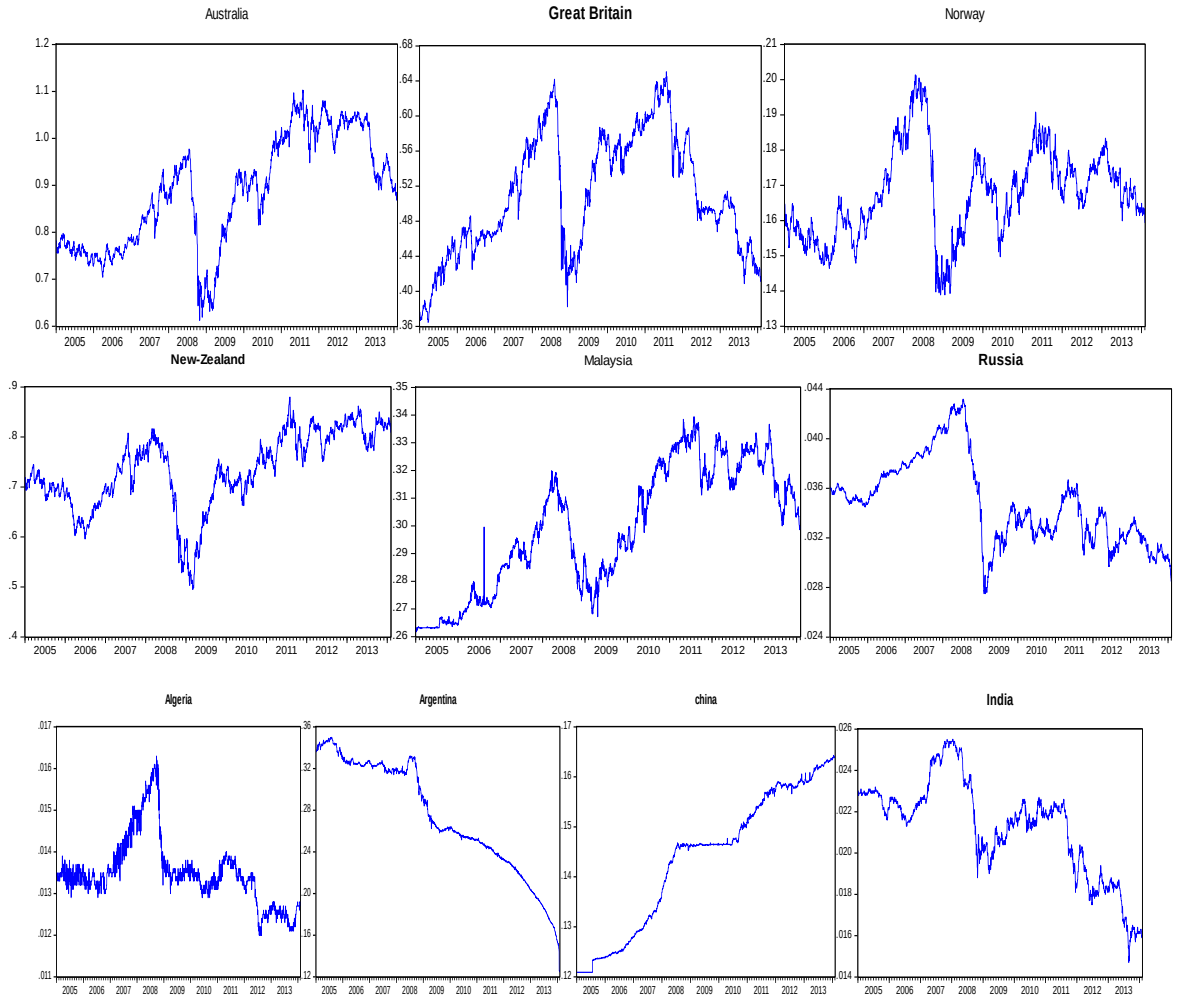


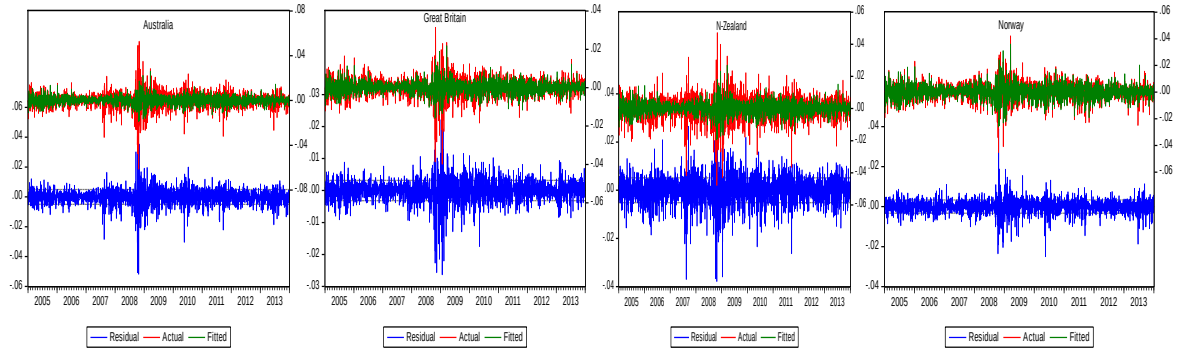
Table 01: descriptive statistics of exchange rate returns from 17.07.2007 to 31.08.2009 (financial Crisis)

	Australia	Great Britain	Algeria	Argentina	china	Norway	N-Zealand	India	Malaysia	Russia
Mean	0.0000	-0.0003	-0.0001	-0.0003	0.0001	-0.0001	-0.0002	-0.0003	0.0000	-0.0003
Maximum	0.053	0.031	0.042	0.035	0.007	0.042	0.047	0.032	0.031	0.031
Minimum	-0.061	-0.040	-0.046	-0.026	-0.008	-0.045	-0.047	-0.025	-0.026	-0.043
Std. Dev.	0.010	0.006	0.010	0.004	0.001	0.008	0.009	0.005	0.004	0.006
Skewness	-0.390	-0.732	-0.085	0.724	-0.142	-0.251	-0.378	0.566	0.183	-1.245
Kurtosis	10	10	8.291	22.564	17.142	8	7.34	9.587	9.388	15.005
Jarque-Bera	1731	1771	907	12459	6477	723.	628.	1446	1325	4867
Observations	777	777	777	777	777	777	777	777	777	777

Table 02: descriptive statistics of exchange rate returns from 03.1.2005 to 02.1.2014 (Entire period)

	Australia	Great Britain	Algeria	Argentina	China	Norway	N-Zealand	India	Malaysia	Russia
Mean	0.00004	-0.00005	-0.00002	-0.00024	0.00009	0.00000	0.00004	-0.00011	0.00004	-0.00005
Max	0.053	0.031	0.065	0.035	0.020	0.042	0.047	0.032	0.098	0.031
Min	-0.061	-0.040	-0.046	-0.026	-0.010	-0.045	-0.048	-0.027	-0.098	-0.043
Std. Dev.	0.006	0.004	0.009	0.002	0.001	0.006	0.006	0.005	0.004	0.004
Skewness	-0.458	-0.603	0.072	0.519	2.307	-0.304	-0.448	0.032	0.242	-0.751
Kurtosis	14.567	11.952	9.986	31.077	72.430	8.247	8.948	8.624	198.670	14.011
Jarque-Bera	18450	11182.	6691	108180	663526	3823.	4957.	4334	5246929	16926
Observations	3287	3287	3287	3287	3287	3287	3287	3287	3287	3287

Figure 02 : Arch effets



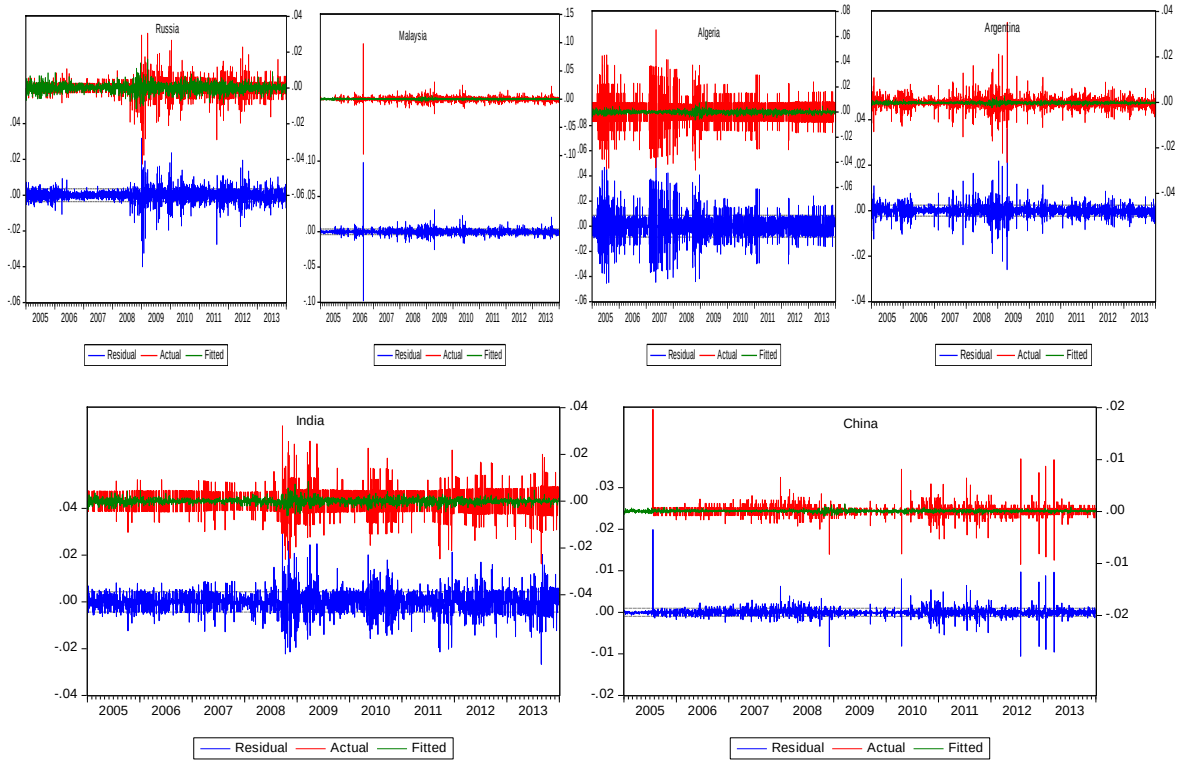


Table 3: Parameter Estimates for GARCH Model for exchange rate returns from17/07/2007 31/08/2009

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
N-Zealand	-0.000126*	1.008644*	0.079832*	0.890858*	0.97069
Norway	0.000156	1.154827*	0.193152*	0.798383*	0.991535
ab Russia	1.86E-05	0.552558*	0.081106*	0.925979*	1.007085
Algeria	-0.000189	0.301162*	0.137718*	0.819069*	0.956787
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 4: Parameter Estimates for GARCH Model for exchange rate returns from 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
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
Australia	0.0000933	0.745604*	0.059159*	0.928003*	0.987162
Great Britain	0.000177	0.633037*	0.042441*	0.952221*	0.994662
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

Table 5: Independently floating exchange regimes

	Australia	Great Britain	the Philippines	Iceland	Mexico	Norway	N-Zealand
Subprime crisis	0,95	0,76	0,22	1,01	0,14	1,15	0,90
Pre-crisis	0,70	0,76	0,12	0,73	0,11	1,32	0,70
% differencesubpcrisis	35,71	0,26	83,33	38,36	27,27	-12,88	28,57

Table 6: Managed float rate regimes

	Algeria	Argentina	china	India	Malaysia	Nigeria	Russia
Subprime crisis	0,30	0,07	0,05	0,22	0,32	0,09	0,56
Pre-crisis	0,27	0,06	0,02	0,12	0,30	0,08	0,29
% differencesubpcrisis	11,11	16,67	150	83,33	6,67	12,50	93,10