Response of international stock markets to oil price shocks

Achraf Ghorbel
Department of economics in university of SFAX-TUNISIA;
URECA Research Unit, Faculty of Economics and Management
Road of airport km4.5 b.p sfax 3018
Tel (216) 23469140
Fax: (216)74279139
Email: ghorbelachraf@hotmail.fr

BOUJELBENE Younes
Department of Economics, university of SFAX-TUNISIA;
URECA Research Unit, Faculty of Economics and Management
Road of airport km 4.5 b.p Sfax 3018
Tel (216) 22684420
Fax: (216)74279139
Email:.boujelbeneyounes@yahoo.fr

Abstract

In this paper we study the impact of oil price shocks on a large set of mature and emerging stock market returns. We use an unrestricted vector autoregression (VAR) model.
Empirical results show that oil price shocks have a statistically significant impact on real stock returns contemporaneously and/or within the following month in 27 countries over 1997:1–2009:08. U.K, Norway, Canada, Mexico and Russia as an oil exporters and U.S, France, Belgium, Germany, Italy, Denmark, Greece, Sweden, Netherlands, Switzerland, Portugal, Japan, Korea, China, Hong Kong, Malaysia, Indonesia, Singapore, Brazil and Argentina as oil importers show a significant positive or negative response of real stock returns to an oil price increase.

Keywords: *real stock returns, oil price shocks, volatility, vector autoregression (VAR) model.*

1. Introduction

Now it is well documented that volatility shocks in crude oil markets have significant effects on a variety of economic activities and certain macroeconomic variables, such as, real GDP growth rates, inflation, employment and exchange rates (Hamilton, 1983; Mork, 1989; Lee and Ni, 1995; Hooker, 1999; Davies and Haltiwanger, 2001; Hooker, 2002; Hamilton, 2003). Their studies differ from each other with respect to the power of their empirical findings without providing a general consensus.

Fewer research attempts investigate the effects of oil-price changes on asset prices, such as stock prices or stock returns. Market participants want a framework that identifies how oil-price changes affect stock prices or stock market returns. On theoretical grounds, oil-price shocks affect stock market returns or prices through their effect on expected earnings (Jones et al., 2004). On the issue of the effect of oil price shocks on stock market returns, Jones and Kaul (1996), Sadorsky (1999) and Ciner (2001) report a significant negative connection, while Chen et al. (1986) and Huang et al. (1996) do not.

Jones and Kaul (1996) show that international stock prices do react to oil price shocks. Huang et al. (1996) provide evidence in favor of causality effects from oil futures prices to stock prices. Faff and Brailsford (2000) report that oil-price risk proved equally important to market risk, in the Australian stock market.

El-Sharif et al. (2005), through a sector-based analysis, investigate the relationship between oil prices and stock returns, listed on the London Stock Exchange. Their empirical findings display that a significant positive association between oil prices and oil-related stock returns is present.

By contrast, a negative association between oil price shocks and stock market returns has been reported in several recent papers. Papapetrou (2001) shows that an oil price shock has a negative impact on stock prices, since they negatively affect output, i.e. industrial production, as well as employment growth.

Hong et al. (2002) also identify a negative association between oil-price return and stock-market returns. Pollet (2002) and Driesprong et al. (2003) find that oil-price changes predict stock market returns on a global basis. Nandha and Faff (2008) find oil prices rises have a detrimental effect on stock returns in all sectors except mining and oil and gas industries, O'Neill et al. (2008) find that oil price increases lead to reduced stock returns in the United States, the United Kingdom and France, and Park and Ratti (2008) report that oil price shocks have a statistically significant negative impact on real stock returns in the U.S. and 12

European oil importing countries. Finally, Bjornland (2008) shows that oil prices may affect stock prices,

This study estimates the effects of oil price shocks and oil price volatility on the real stock returns of the 27 countries (mature and emergent) over 1997:1–2009:8. We argue that it is important to consider the effects of oil prices on stock prices in a number of countries in order to better identify effects that may be systematic across countries rather than country specific. It is also important to allow for the effect of uncertainty about oil prices when considering the effect of (linear and non-linear) transformations of movement in oil price on real stock returns since the effect of changes in the latter could be offset by increases in the former. The measure of volatility of crude oil price (Brent) and stocks markets that we use, based on GARH model like proxy of volatility, has extreme values related to major political events concerning the Middle East and may reflect uncertainty about future oil supplies.

In the aforementioned literature, the ARCH-type model introduced by Engle (1982) is one of the most promising and reliable models that specialize in financial time series volatility modeling. ARCH-type models have a long history (approximately three decades) in the applications of financial markets, especially in pricing financial derivatives (Baillie et al., 1996; Bollerslev, 1986; Nelson, 1991) and measuring investment risk (Engle et al, 1987; Jorion, 1997; Giot and Laurent, 2004). In addition, ARCH- type models also play an important role in the literature on crude oil market volatility analysis (Alizadeh et al., 2008; Fong and See, 2002 and Narayan, 2007).

Lee et al.(1995) defended the idea that an oil price change is likely to have greater impact on real GNP in an environment where oil prices are stable, than in an environment where oil price movements are frequent and erratic. These authors used generalised autoregressive conditional heteroscedasticity (GARCH) model (Bollerslev,1986). Lee et al.(1995) proposed the following GARCH(1,1)representation of oil prices:

$$op_t = \alpha + \sum_{i=0}^{p} \alpha_i . op_{t-i} + \sum_{i=0}^{q} \beta_i . z_{t-i} + \varepsilon_t \quad \varepsilon_t / I_{t-1} \approx N(0, h_t), h_t = \gamma_0 + \gamma_2 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1} \ (1)$$

A multivariate VAR analysis is conducted with linear and non-linear specification of oil price shocks. Linear oil price shock is defined as the percentage change in the real price of oil and non-linear measures of real oil price shocks are scaled real oil price shock defined by Lee et al. (1995) and net oil price defined by Hamilton (1996).

The empirical results show that oil price shocks have a statistically significant impact on real stock returns for U.S and 24 countries in the same month or within one month. The contribution of oil price shocks to variability in real stock returns in the U.S. and most other countries is greater than that of interest rate.

2. Variable and data description

In this paper we examine the effect of oil price shocks on real stock returns in the U.S. and in 26 countries (U.K, Canada, France, Italy, Spain, Germany, Netherlands, Denmark, Belgium, Greece, Norway, Sweden, Portugal, Switzerland, Russia, Japan, Korea, Hong Kong, China, Malaysia, Indonesia, Singapore, Thailand, Mexico, Brazil and Argentina) over 1997:1–2009:08.We will use a vector autoregressive model (VAR) to capture the complexities of the dynamic relations between these variables and other variables, including short-term interest rates, exchange rates, and industrial production, that may influence the connections between oil price shocks on real stock returns. At least since the formulation of Fama's (1981) hypothesis, measures of inflation and real activity have played a role in analysis of the behavior of real stock returns. In literature focused on oil price shocks, Sadorsky (1999) considers the effect of oil price shocks on real stock returns in the U.S. within a framework similar to that in this paper, and Jones and Kaul (1996) include industrial production as a proxy variable for cash flow in their analysis of oil and the stock market.

This study examines the monthly data available over 1997.1–2009.08 for stock prices, short-term interest rates, exchange rates, and industrial production for the U.S. and 26 countries. Industrial production data are from OECD for the European countries and from FRED for the U.S and from IFS, IMF, for Asian and Latin American countries. Short-term interest rates (usually Treasury-bill rates) are from IFS, IMF and from Main Economic Indicators, OECD. For the U.S. the three month Treasury-bill rate is from FRED. Stock price indices in U.S. dollar price for all countries for MSCI. Oil price is taken as an index in U.S. dollar price of U.K. Brent crude oil from IMF of U.K. Brent crude oil from IMF. Exchange rates from FRED for all countries.

For each country, real stock returns are defined as the difference between the continuously compounded return on stock price index. Oil price returns is calculated as the difference between the continuously compounded returns on oil price (Brent) and also exchange rate returns is calculated as the difference between the continuously compounded returns on units of currency country i per U.S. dollar. Oil price returns and real stock returns for all countries is shown in Appendix 1(Figure 1 & 2).Volatility of oil price returns and volatility stocks markets returns for all countries is shown in Appendix 2(Figure 3 & 4).

Figure 1 plots returns of oil price (Brent) during 1997.1–2009.08 periods. We clearly show that oil price have a significantly sharp decrease between mid-2008 and 2009.

Figure 2 plots returns of indexes prices during 1997.1–2009.08. We clearly show that most of stock market indexes have a significantly sharp decrease between mid-2007 and 2009. Over this period, indexes prices in all countries studied, have followed the same downward trend as the U.S. index

Figure 3 plots the volatility of oil price returns (Brent) when we show a peak of volatility during mid-2008 and 2009, particularly in July 2008.

Figure 4 plots the volatility of indexes during 1997.1–2009.08. We notice that the current financial crisis dramatically influenced the market volatility which has been high during 2007-2009, particularly during the 2008 period. Moreover, volatility presents a peak during the recent crisis.

Also, figure 4 presents the behavior of volatility during past financial crises. Stock markets of Korea, China, Hong Kong, Japan, Malaysia, Thailand, Indonesia and Singapore present high level of volatility in 1999 which reflects persistent of 1997 East Asian crisis.

The high volatility show the peak of volatility for Brazil, Mexico, Argentina, Russia, Germany, France, Sweden, Switzerland, Netherland stocks markets during this period appears to be the result of the currency crisis.

In order to keep notation as simple as possible country suffices will be suppressed. The following notation will be employed:

r: short-term interest rate on level

ip: first log difference of industrial production

rsr: real stock returns

op: oil price returns

rex: exchange rate returns

3. **Empirical analysis**

In order to analyze the effects of the recent fluctuations in oil price on economic activity and to take into consideration the transmission channels of oil price shock, we will follow the following steps: first, we proceed to investigate the properties of the series of which we check the stationarity of each variable by the unit-root tests Augmented Dickey Fuller (ADF) and Phillips and Perron (PP). Since the variables the short- term interest rate on level and industrial production in log level each contain a unit root, we conduct cointegration test (Johansen and Juselius, 1990) for common stochastic trend. Finally, an investigation of the impact of oil price on the macroeconomy will be made by the study of the impulse response functions and variance decomposition. The optimal lag length of the VAR model was examined by the information criterion of Akaike (AIC), Schwartz (SIC), Likelihood Ratio (LR) and Hannan-Quinn (HQ) which is equal to one.

The empirical framework for investigating the complexities of the dynamic connections between oil price shocks and stock prices in this paper is an unrestricted vector autoregression (VAR) model. A VAR model has been frequently used to analyze the impact of oil price shocks on economic activity since work by Darby (1982) and Hamilton (1983). The main advantage of this model is the ability to capture the dynamic relationships among the economic variables of interest. A VAR model consists of a system of equations that expresses each variable in the system as a linear function of its own lagged value and lagged values of all the other variables in the system. For example, a VAR of order p, where the order p represents the number of lags, that includes k variables, can be expressed as:

$$y_t = A_0 + \sum_{i=1}^{p} A_i y_{t-i} + u_t \qquad (2)$$

where $\mathbf{y_t} = [y_{1t} \ldots y_{kt}]'$ is a column vector of observation on the current values of all variables in the model, A_i is k ×k matrix of unknown coefficients, A_0 is a column vector of deterministic constant terms, u_t is a column vector of errors with the properties of $E(u_t) = 0$ for all t, $E(u_s u_t')$ $= \mathbf{\Omega}$ if s = t and $E(u_s u_t') = 0$ if $s \neq t$, where Ω is the variance–covariance matrix. Thus, $\mathbf{u}_t$'s are assumed to be serially uncorrelated but may be contemporaneously correlated and Ω is assumed to have non-zero off-diagonal elements. All the variables, $y_t = [y_{1t} \ldots y_{kt}]'$, in the model must have the same order of integration.

Our basic VAR model will have the five variables, first log difference of industrial production (ip), oil price returns (op), short-term interest rate on level (r), exchange rate returns (rex) and real stock returns (rsr). Lag length in Eq. (2), p, will be taken to be 6 for VAR model.[1]

3.1. Unit root tests

We test for unit roots in the natural logarithms of our variables for each country. We test the null hypothesis of non-stationary variables versus the alternative hypothesis of stationary variables using the Augmented Dickey–Fuller (ADF) and Phillips and Perron (PP) statistics (Dickey and Fuller, 1981; Phillips and Perron, 1988). We employ the Akaike information criteria (AIC) to select the lag length from the ADF test. Tables 1 & 2 reports the results with

[1] A check of optimal lag length based on LR, AIC, and BSIC criteria for the various VAR specifications across country and oil price variables yielded a range of results, with some less that 6 and some more than 6.

and without a trend. With one exception, we reject the null hypothesis that all variables contain a unit root at the 5-percent significant level for real stock returns (rsr), oil price returns (op) and exchange rate returns (rex) suggesting that the our study are I(0) (stationary of rsr and op) . For the exception, we cannot reject the null hypothesis of a unit root for short term interest rate on level (r) and first log difference of industrial production (ip).

Table 1
PP unit root test results

	Real exchange returns (country i / U.S. Foreign Exchange Rate)	
	C	C&T
US ($/euro)	-8.645 [a]	-8.677 [a]
UK	-8.872 [a]	-8.848 [a]
Italy	-8.947 [a]	-8.987 [a]
Belgium	-3.926 [a]	-3.894 [a]
France	-8.859 [a]	-8.897 [a]
Germany	-11.855 [a]	-11.82 [a]
Portugal	-10.803 [a]	-10.776 [a]
Sweden	-8.337 [a]	-8.35 [a]
Spain	-9.003 [a]	-9.051 [a]
Norway	-7.92 [a]	-7.963 [a]
Switzerland	-12.718 [a]	-12.719 [a]
Canada	-9.056 [a]	-9.091 [a]
Denmark	-8.822 [a]	-8.862 [a]
Greece	-8.991 [a]	-9.01 [a]
Netherland	-8.849 [a]	-8.895 [a]
Russia	-8.908 [a]	-8.982 [a]
Japan	-9.632 [a]	-9.602 [a]
Korea	-6.599 [a]	-6.587 [a]
China	-6.339 [a]	-7.062 [a]
Indonesia	-8.195 [a]	-8.221 [a]
Malaysia	-9.532 [a]	-9.764 [a]
Singapore	-9.065 [a]	-9.376 [a]
HongKong	-9.708 [a]	-9.81 [a]
Thailand	-9.24 [a]	-9.383 [a]
Mexique	-9.246 [a]	-9.214 [a]
Argentina	-7.135 [a]	-7.112 [a]
Brazil	-7.423 [a]	-7.544 [a]

	Real stocks and oil price returns	
	C	C&T
oil price	-12.414[a]	-12.374[a]
US	-10.723 [a]	-10.741[a]
UK	-9.287 [a]	-9.273 [a]
Italy	-11.052 [a]	-11.044 [a]
Belgium	-8.588 [a]	-8.577 [a]
France	-10.419 [a]	-10.401[a]
Germany	-11.098 [a]	-11.070 [a]
Portugal	-10.163 [a]	-10.128 [a]
Sweden	-10.693 [a]	-10.663 [a]
Spain	-10.518 [a]	-10.546 [a]
Norway	-9.958 [a]	-9.933 [a]
Swisse	-10.236 [a]	-10.221 [a]
Canada	-10.051 [a]	-10.017 [a]
Denmark	-10.702 [a]	-10.669 [a]
Greece	-10.953 [a]	-10.922 [a]
Netherland	-10.692 [a]	-10.669 [a]
Russia	-10.069 [a]	-10.029 [a]
Japan	-10.349 [a]	-10.313 [a]
Korea	-11.356 [a]	-11.321[a]
China	-11.001 [a]	-11.133 [a]
Indonesia	-9.629 [a]	-9.774 [a]
Malaysia	-9.436 [a]	-9.560 [a]
Singapore	-10.751 [a]	-10.725 [a]
Indonesia	-9.629 [a]	-9.774 [a]
HongKong	-10.363 [a]	-10.345 [a]
Thailand	-12.167 [a]	-12.296 [a]
Mexique	-11.986 [a]	-11.949 [a]
Argentina	-11.195 [a]	-11.175 [a]
Brazil	-11.676 [a]	-11.720 [a]

	Industrial production in log level		Industrial production in First log difference		Interest rate in level		Interest rate in First level difference	
	C	C&T	C	C&T	C	C&T	C	C&T
US	-0.528	-2.762	-8.643 [a]	-8.632 [a]	-1.034	-1.502	-7.878 [a]	-7.877 [a]
UK	0.264	-2.321	-8.203 [a]	-8.303 [a]	-0.523	-1.347	-7.339 [a]	-7.440 [a]
Italy	-0.60	-2.269	-6.042 [a]	-6.023 [a]	-2.001	-2.164	-5.976 [a]	-5.969 [a]
Belgium	-0.729	-2.654	-6.819 [a]	-6.80 [a]	-1.543	-1.656	-6.012 [a]	-6.093 [a]
France	-0.760	-2.418	-11.45 [a]	-11.422 [a]	-1.515	-1.623	-5.677 [a]	-5.751 [a]
Germany	-0.50	-2.199	-8.80 [a]	-8.78 [a]	-1.537	-1.622	-5.698 [a]	-5.77 [a]
Portugal	-1.026	-2.398	-7.109 [a]	-7.085 [a]	-2.045	-2.507	-6.465 [a]	-6.448 [a]
Sweden	0.389	-2.354	-11.345 [a]	-11.359 [a]	-0.987	-1.814	-6.802 [a]	-6.852 [a]
Spain	0.055	-2.31	-6.538 [a]	-6.547 [a]	-1.855	-2.055	-5.636 [a]	-5.617 [a]
Norway	-0.520	-2.81	-9.088 [a]	-9.044 [a]	-1.569	-1.973	-5.454 [a]	-5.515 [a]
Switzerland	-0.391	-1.267	-11.275 [a]	-11.24 [a]	-1.582	-1.635	-9.57 [a]	-9.561 [a]
Canada	-5.47	-6.688	-27.349 [a]	-32.363 [a]	-0.841	-1.645	-6.422 [a]	-6.614 [a]
Denmark	-1.794	-2.099	-11.09 [a]	-11.099 [a]	-1.624	-1.794	-7.492 [a]	-7.553 [a]
Greece	-3.029	-3.314	-21.035 [a]	-63.995 [a]	-1.581	-1.426	-10.751 [a]	-10.734 [a]
Netherland	-0.786	-2.247	-10.216 [a]	-10.191 [a]	-1.541	-1.617	-5.769 [a]	-5.869 [a]
Russia	-2.220	-1.524	-9.417 [a]	-9.579 [a]	-4.196 [a]	-4.991 [a]	-15.552 [a]	-15.504 [a]
Japan	-1.681	-1.415	-6.785 [a]	-6.916 [a]	-1.374	-2.017	-14.084 [a]	-14.122 [a]
Korea	-1.026	-2.398	-7.109 [a]	-7.085 [a]	-2.045	-2.507	-6.465 [a]	-6.448 [a]
China	-9.593 [a]	-10.112 [a]	-34.966 [a]	-35.382 [a]	-3.229	-2.819	-16.762 [a]	-16.898 [a]
Indonesia	-2.103	-2.568	-7.319 [a]	-7.372 [a]	-1.632	-2.499	-6.177 [a]	-6.156 [a]
Malaysia	-1.418	-3.915 [b]	-20.924 [a]	-20.998 [a]	-1.938	-1.806	-9.669 [a]	-14.756 [a]
Singapore	-1.539	-2.606	-5.617 [a]	-5.621 [a]	-2.683	-2.715	-9.23 [a]	-9.242 [a]
HongKong	-4.765	0.876	-8.851 [a]	-11.622 [a]	-1.664	-2.775	-16.875 [a]	-16.829 [a]
Thailand	-0.967	-2.327	-6.604 [a]	-6.497 [a]	-1.671	-1.610	-7.94 [a]	-7.949 [a]
Mexique	-2.111	-2.190	-8.564 [a]	-8.716 [a]	-1.754	-2.483	-9.513 [a]	-9.481 [a]
Argentina	-1.123	-1.992	-11.072 [a]	-11.032 [a]	-4.988 [a]	-4.971 [a]	-46.19 [a]	-46.341 [a]
Brazil	-1.387	-2.387	-11.202 [a]	-11.201 [a]	-2.815 [c]	-4.796 [a]	-16.335 [a]	-16.275 [a]

Table 2
ADF unit root test results

	Industrial production in log level		Industrial production in First log difference		Interest rate in level		Interest rate in First level difference	
	C	C&T	C	C&T	C	C&T	C	C&T
US	-0.588	-2.740	-8.560 [a]	-8.546 [a]	-1.532	-1.935	-7.548 [a]	-7.546 [a]
UK	0.109	-2.149	-8.120 [a]	-8.222 [a]	-0.534	-1.389	-7.209 [a]	-7.315 [a]
Italy	-0.662	-2.657	-5.928 [a]	-5.907 [a]	-2.376	-2.519	-5.957 [a]	-5.949 [a]
Belgium	-0.687	-3.825	-6.597 [a]	-6.576 [a]	-1.731	-1.857	-6.017 [a]	-6.087 [a]
France	-0.491	-2.928	-6.403 [a]	-6.381 [a]	-1.828	-1.954	-5.686 [a]	-5.753 [a]
Germany	-1.027	-3.194	-3.314 [b]	-3.289 [c]	-1.863	-1.966	-5.712 [a]	-5.778 [a]
Portugal	-1.153	-2.837	-7.084 [a]	-7.060 [a]	-2.205	-2.499	-4.526 [a]	-4.552 [a]
Sweden	0.452	-2.298	-11.335 [a]	-11.360 [a]	-2.091	-2.784	-4.670 [a]	-4.673 [a]
Spain	-0.104	-2.542	-6.538 [a]	-6.547 [a]	-2.095	-2.313	-5.651 [a]	-5.634 [a]
Norway	-0.713	-3.215	-9.316 [a]	-9.277 [a]	-2.133	-2.624	-4.194 [a]	-4.274 [a]
Switzerland	-0.252	-1.039	-11.195 [a]	-11.162 [a]	-1.607	-1.661	-9.583 [a]	-9.576 [a]
Canada	-2.205	-1.196	-2.070	-2.770	-1.048	-1.904	-6.340 [a]	-6.517 [a]
Denmark	-1.768	-1.991	-11.125 [a]	-11.129 [a]	-2.092	-2.263	-4.764 [a]	-4.819 [a]
Greece	-2.857	-2.552	-8.734 [a]	-9.217 [a]	-1.240	-1.239	-4.212 [a]	-4.153 [a]
Netherland	-0.915	-2.992	-4.219 [a]	-4.204 [a]	-1.825	1.930	-5.776 [a]	-5.864 [a]
Russia	-2.915	-1.271	-8.845 [a]	-9.154 [a]	-4.274	-4.895	-12.018 [a]	-11.990 [a]
Japan	-1.811	-1.581	-6.867 [a]	-6.916 [a]	-1.455	-2.087	-14.147 [a]	-14.149 [a]
Korea	-1.153	-2.837	-7.084 [a]	-7.060 [a]	-2.205	-2.499	-4.526 [a]	-4.552 [a]
China	-2.955	3.341	-11.447 [a]	-11.441 [a]	-2.716	-2.423	-6.449 [a]	-6.571 [a]
Indonesia	-2.691	-3.870	-3.737 [a]	-3.958 [b]	-2.856	-2.632	-3.286 [b]	-3.596 [b]
Malaysia	-1.656	-2.488	-1.940	-1.932	-2.421	-2.510	-8.935 [a]	-8.433 [a]
Singapore	-2.087	-4.121 [a]	-6.562 [a]	-6.551 [a]	-3.323	-3.372	-8.427 [a]	-8.432 [a]
HongKong	-2.123	0.953	-1.609	-11.579 [a]	-1.273	-2.190	-16.413 [a]	-16.371 [a]
Thailand	-1.111	-2.966	-6.662 [a]	-6.642 [a]	-1.748	-1.622	-7.908 [a]	-7.919 [a]
Mexique	-2.058	-2.402	-8.366 [a]	-8.594 [a]	-1.701	-2.605	-9.551 [a]	-9.520 [a]
Argentina	-1.176	-1.907	-11.031 [a]	-11.001 [a]	-5.192 [a]	-5.175 [a]	-10.447 [a]	-10.410 [a]
Brazil	-1.362	-2.387	-11.216 [a]	-11.201 [a]	-1.493	-3.058	-9.248 [a]	-9.219 [a]

	Real exchange returns (country i / U.S. Foreign Exchange Rate)	
	C	C&T
US ($/euro)	-8.809 [a]	-8.867 [a]
UK	-8.782 [a]	-8.760 [a]
Italy	-9.088 [a]	-9.142 [a]
Belgium	-4.245 [a]	-4.058 [a]
France	-9.013 [a]	-9.067 [a]
Germany	-11.855 [a]	-11.820 [a]
Portugal	-10.809 [a]	-10.796 [a]
Sweden	-8.439 [a]	-8.450 [a]
Spain	-9.136 [a]	-9.189 [a]
Norway	-8.040 [a]	-8.080 [a]
Switzerland	-12.626 [a]	-12.594 [a]
Canada	-8.935 [a]	-8.979 [a]
Denmark	-8.972 [a]	-9.033 [a]
Greece	-8.948 [a]	-9.105 [a]
Netherland	-9.000 [a]	-9.060 [a]
Russia	-8.569 [a]	-8.730 [a]
Japan	-9.614 [a]	-9.614 [a]
Korea	-8.834 [a]	-8.827 [a]
China	-3.557 [a]	-3.985 [b]
Indonesia	-8.195 [a]	-8.221 [a]
Malaysia	-4.443 [a]	-4.394 [a]
Singapore	-9.268 [a]	-9.616 [a]
HongKong	-9.675 [a]	-9.738 [a]
Thailand	-9.275 [a]	-9.441 [a]
Mexique	-9.312 [a]	-9.280 [a]
Argentina	-7.019 [a]	-6.995 [a]
Brazil	-7.813 [a]	-8.073 [a]

	Real stocks and oil price returns	
	C	C&T
oil price	-12.413 [a]	-12.373 [a]
US	-10.658 [a]	-10.726 [a]
UK	-9.036 [a]	-9.048 [a]
Italy	-10.870 [a]	-10.889 [a]
Belgium	-8.492 [a]	-8.500 [a]
France	-10.349 [a]	-10.34 [a]
Germany	-11.052 [a]	-11.023 [a]
Portugal	-10.119 [a]	-10.083 [a]
Sweden	-10.478 [a]	-10.447 [a]
Spain	-10.583 [a]	-10.603 [a]
Norway	-9.920 [a]	-9.896 [a]
Switzerland	-10.222 [a]	-10.207 [a]
Canada	-9.978 [a]	-9.943 [a]
Denmark	-10.550 [a]	-10.516 [a]
Greece	-10.799 [a]	-10.769 [a]
Netherland	-10.676 [a]	-10.657 [a]
Russia	-10.104 [a]	-10.066 [a]
Japan	-5.471 [a]	-5.453 [a]
Korea	-11.354 [a]	-11.319 [a]
China	-11.018 [a]	-11.172 [a]
Indonesia	-8.969 [a]	-9.243 [a]
Malaysia	-9.345 [a]	-9.472 [a]
Singapore	-10.868 [a]	-10.896 [a]
HongKong	-10.412 [a]	-10.413 [a]
Thailand	-12.131 [a]	-12.282 [a]
Mexique	-11.951 [a]	-11.912 [a]
Argentina	-11.121 [a]	-11.101 [a]
Brazil	-11.659 [a]	-11.709 [a]

Notes: ADF—Dickey and Fuller (1981) and PP—Phillips and Perron (1988); C—constant; T—trend. Superscripts a, b, and c, denote rejection of the null hypothesis of a unit root at the 1%, 5%, and 10%, level of significance, respectively.

3.2. Cointegration tests

We employ cointegration tests, based on the methodology of Johansen and Juselius (1990), for the variables that characterize the oil market, exchange market, short-term interest rate and real stocks markets. Table 3 reports the tests for cointegration. As a pre-test, we estimate VAR models with varying lag lengths and perform F-tests to select the appropriate lag length. In all cases, we choose six lags. The trace test statistics recommend that a long-run relationship exist among the five jointly determined variables in either case. Thus, we proceed to estimate VAR models for this variables on level for all twenties eight countries.

Table 3: Cointegration test

Country	Hypothesis	r=0	r=<1	r=<2	r=<3	Country	Hypothesis	r=0	r=<1	r=<2	r=<3
U.S.	Trace test	98.642 [a]	64.164 [b]	33.862	10.319	**Switzerland**	Trace test	89.827 b	52.180	27.399	10.735
	λ max test	34.477	30.302	23.542	7.396		λ max test	37.647	24.780	16.663	8.117
Germany	Trace test	94.350 [b]	57.665	37.233	22.754	**Russia**	Trace test	117.728 [a]	72.130 [a]	30.835	9.326
	λ max test	36.685	20.432	14.478	11.814		λ max test	45.597 [a]	41.295 [a]	21.509	8.971
Belgium	Trace test	115.51 [a]	75.214 [a]	47.334 [b]	26.303 [b]	**Japan**	Trace test	77.015 [b]	37.100	18.784	7.939
	λ max test	40.303 [b]	27.879	21.030	16.231		λ max test	38.914 [b]	18.315	10.845	5.928
France	Trace test	92.115 [a]	57.605 [b]	30.321 [b]	13.907	**Korea**	Trace test	106.382 [b]	51.477	30.433	12.525
	λ max test	34.510 [b]	27.283	16.414	13.907		λ max test	54.904 [a]	21.044	17.908	8.296
Canada	Trace test	95.014 [a]	55.907 [b]	25.747	8.695	**Hong Kong**	Trace test	91.933 [a]	51.591	30.768	12.437
	λ max test	39.107 [a]	30.159	17.052	8.629		λ max test	40.341 [b]	20.823	18.330	11.068
Denmark	Trace test	82.674 [b]	54.191 [b]	35.639 [b]	20.00	**China**	Trace test	102.26 [a]	64.151 [a]	27.435	11.709
	λ max test	28.482	18.551	15.639	12.926		λ max test	38.110 [b]	36.715 [a]	15.726	11.509
Greece	Trace test	106.010 [a]	70.485 [a]	41.557 [a]	20.710 [b]	**Malaysia**	Trace test	127.42 [a]	74.423 [a]	38.684 [b]	13.131
	λ max test	35.524 [b]	28.928 [b]	20.846	12.493		λ max test	52.997 [a]	35.738 [a]	25.552 [b]	9.287
Spain	Trace test	76.277 [b]	45.145	18.707	7.794	**Indonesia**	Trace test	123.02 [a]	83.633 [a]	46.729 [b]	22.797
	λ max test	31.132	26.438	10.913	6.665		λ max test	39.386 [b]	36.904 [b]	23.932	18.002
U.K	Trace test	99.106 [a]	67.414 [b]	39.522	17.775	**Singapore**	Trace test	125.166 [a]	64.998 [a]	35.290 [b]	7.985
	λ max test	31.692	27.891	21.747	12.912		λ max test	60.168 [a]	29.707	27.305 [b]	4.821
Italy	Trace test	115.81 [a]	73.964 [a]	46.535 [b]	26.354 [b]	**Thailand**	Trace test	134.253 [a]	72.382 [a]	21.580	7.376
	λ max test	41.854 [b]	27.429	20.181	18.841		λ max test	61.870 [a]	50.802 [a]	14.203	5.678
Netherland	Trace test	125.695 [a]	79.352 [a]	47.254 [b]	23.812	**Mexico**	Trace test	77.995 [a]	41.105	15.541	4.239
	λ max test	46.342 [a]	32.097	23.442	14.878		λ max test	36.890 [b]	25.563	11.302	3.958
Norway	Trace test	104.701 [a]	61.24	30.297	15.138	**Brazil**	Trace test	90.790 [a]	46.502 [b]	17.366	3.956
	λ max test	43.460 [b]	30.943	15.158	9.516		λ max test	44.288 [a]	29.135 [a]	13.410	3.453
Portugal	Trace test	114.845 [a]	75.067 [a]	38.495	13.953	**Argentina**	Trace test	122.734 [a]	73.671 [a]	32.535	13.535
	λ max test	39.778 [a]	36.571 [a]	24.542	10.070		λ max test	49.063 [a]	41.135 [a]	18.999	13.535
Sweden	Trace test	131.663 [a]	80.020 [a]	45.300 [b]	23.737						
	λ max test	51.643 [a]	34.719 [b]	21.563	17.429						

Notes: Johansen and Juselius (1990) test statistic for cointegration. The number of cointegrating vectors is indicated by r. Superscripts a and b denote rejection of the null hypothesis at the 1% and 5% levels of significance, respectively.

3.4. Impact of oil price shock on stock market

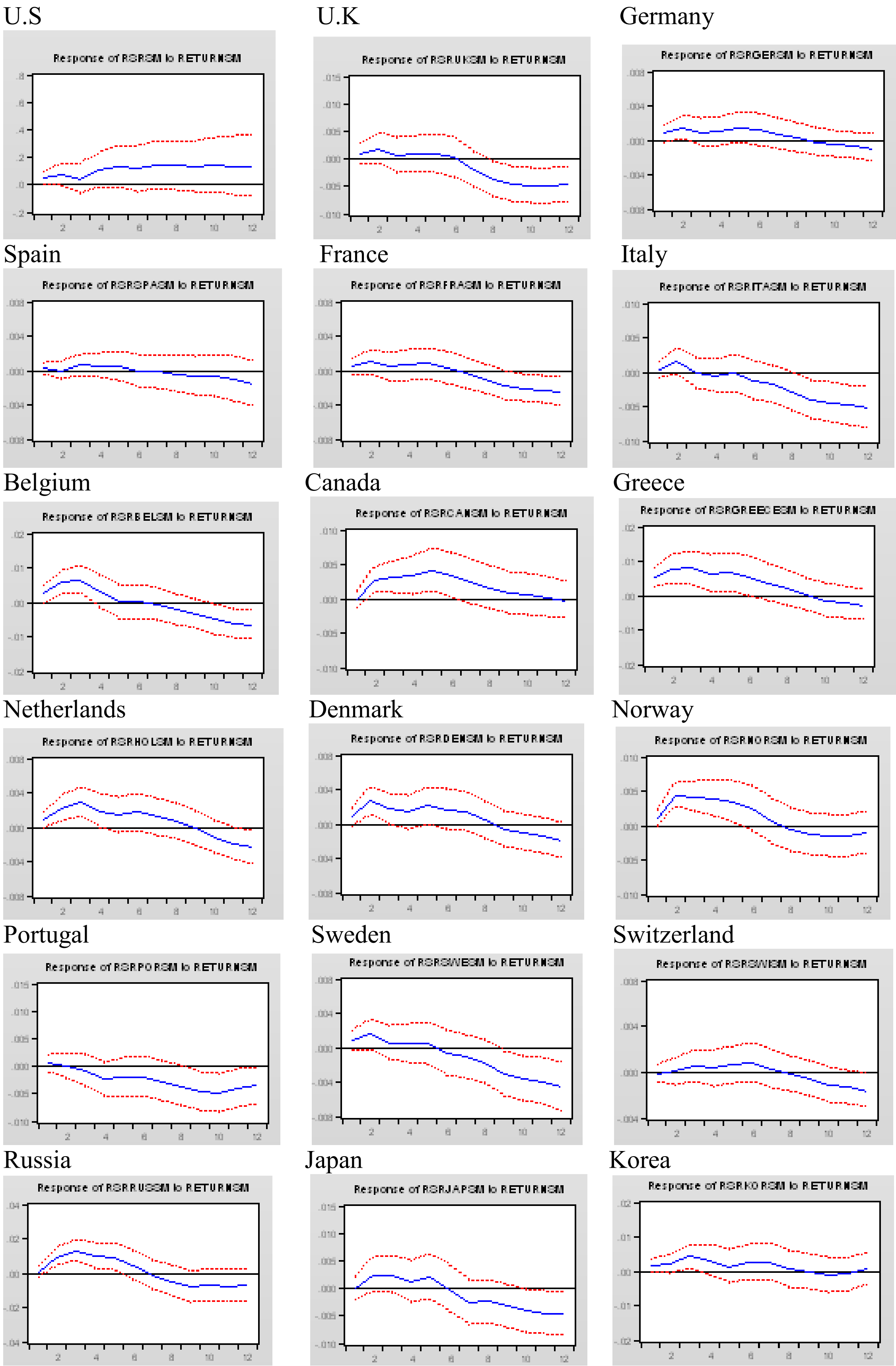
In this section we asses the impact of real oil price shock on real stock returns by examining orthogonalized impulse responses. The orthogonal innovations, denoted by ε_t, are obtained by transforming the errors terms in Eq. (4) by $\varepsilon_t = qu_t$ such that $\mathbf{q\Omega q'=I}$, where q is any lower triangular matrix, I is an identity matrix, and Ω is the covariance matrix of the residual u_t. The orthogonal innovations $u_t = q\varepsilon_t$ then satisfy $E(u_t u_t') = \mathbf{I}$.

The orthogonalized impulse responses of the variables in the model are obtained as a moving average representation of a five-variable VAR with variables placed in the following order: first log difference of industrial production; oil price returns; short-term interest rate on level; real exchange rate and real stock returns. The order of variables in this VAR model is indicated by the notation. With this order of variables, shocks to the interest rate, oil prices, exchange rate and industrial production have possible contemporary effect on real stock returns, but not the other way around. Since the order of variables can sometimes have important effects on results, orthogonalized impulse responses from VAR systems with different ordering and additional variables including oil price volatility. Orthogonalized impulse responses of real stock returns from a one standard deviation shock to oil price measured by the oil returns from the VAR(ip, op, r, rex, rsr) are shown in Fig. 2.

Results for 27 countries and 95% confidence bounds around each orthogonalized impulse response appear in Fig. 2. Table 4 summarizes the results in Fig. 2. In Table 4 an n (p) indicates negative (positive) statistically significant orthogonalized impulse response at 5% level of real stock return to oil price shock contemporaneously and/or at lag of one month. The superscript # indicates that statistical significance is at 10% level. A summary of orthogonalized impulse response results for the impacts on real stock returns of shocks to oil returns, from the models VAR(ip, op, r, rex , rsr).

For the U.S. and for eighteen of twenty-six mature and emerging countries (Germany, Netherlands, Portugal, Belgium, Greece, Denmark, Norway, Canada, Russia, China, Indonesia, Hong Kong, Malaysia, Singapore, Korea, Mexico, Argentina and Brazil) an oil price shock has a positive and statistically significant impact on real stock returns at the 5% level in the same month and/or within one month. In later months the orthogonalized impulse responses vary between being negative and positive, with some statistically significant effects in some months for some countries. By contrast, an oil price shock has a negative and statistically significant impact on real stock returns for U.K, France, Italy, Sweden, Switzerland and Japan. The contribution of oil price shocks to variability in real stock returns in the U.S. and most other countries is greater than that of interest rate.

Fig. 2. Oil price shocks: Orthogonalized impulse response function of real stock returns to linear oil price shocks in VAR(ip, op, r,rex, rsr).



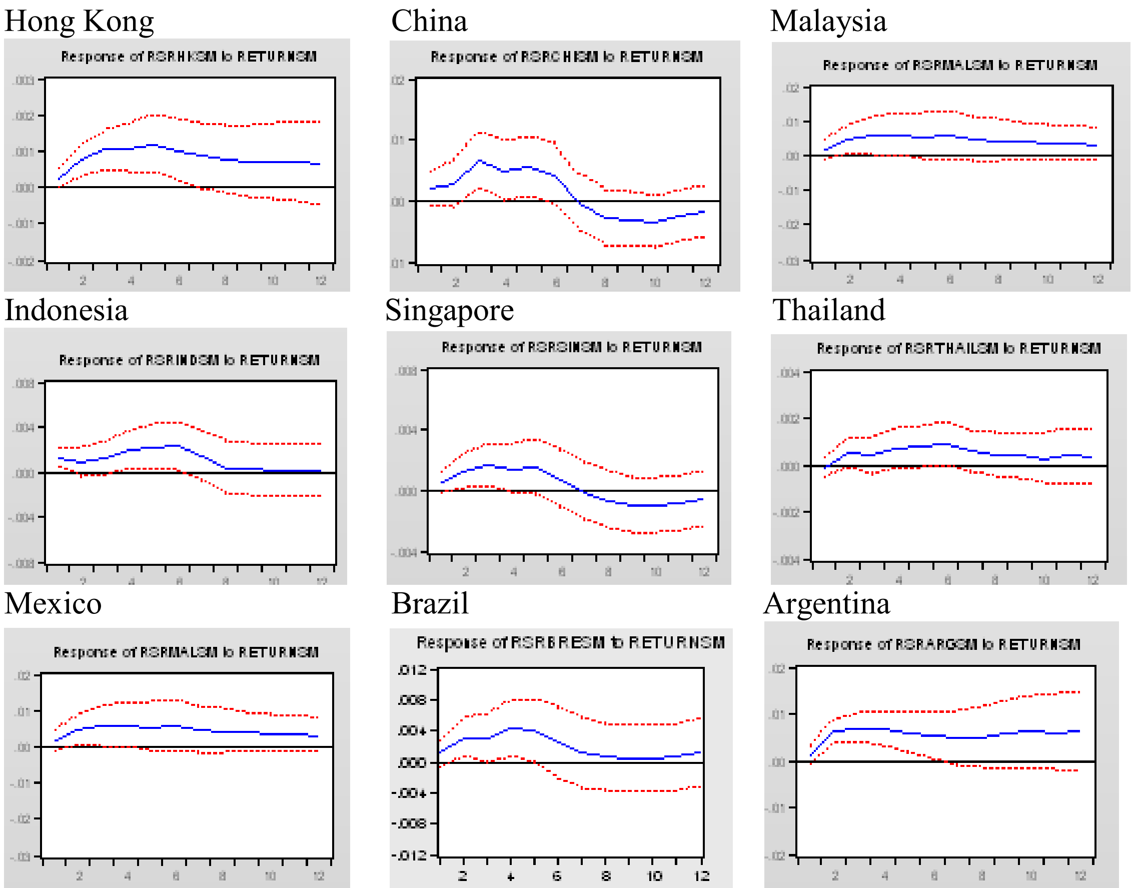


Table 4: orthogonalized impulse response of real stock return to oil price shock: VAR(ip, op, r, rex, rsr) (contemporaneously and/or with lag of one month)

	U.K.	**Canada**	**Norway**	**Russia**	**Mexico**	**U.S.**	**France**
	Sign of statistically significant effect on real stock returns of shock to oil price return						
Shock to op	n#	p#	p#	p#	p#	p#	n#
	Italy	**Belgium**	**Spain**	**Germany**	**Greece**	**Denmark**	**Netherland**
Shock to op	n#	p#	n	p#	p#	p#	p#
	Switzerland	**Sweden**	**Japan**	**Portugal**	**Korea**	**Hong Kong**	**China**
Shock to op	n#	n#	n#	p#	p#	p#	p#
	Malaysia	**Indonesia**	**Singapore**	**Thailand**	**Argentina**	**Brazil**	
Shock to op	p#	p#	p#	p	p#	p#	

Notes: n (p) indicates negative (positive) statistically significant orthogonalized impulse response at 5% level of real stock return to oil price shock at first and/or second lag. The superscript # indicates that statistic significance is at 10% level.

4. Conclusion

The vast literature establishing robust results across many countries on the connection between oil price shocks and aggregate activity implies that connections should also hold between oil price shocks and stock markets. This study estimates the effects of oil price shocks on the real stock returns of the U.S. and 26 mature and emerging countries over 1997:1–2009:8 using a multivariate VAR analysis. We find that oil price shocks have a statistically significant impact on real stock returns in the same month or within one month. A summary of orthogonalized impulse response results for the impacts on real stock returns of shocks to oil price returns, from the models VAR(ip, op, r, rex , rsr). For the U.S. and for eighteen of twenty-six mature and emerging countries (Germany, Netherlands, Portugal, Belgium, Greece, Denmark, Norway, Canada, Russia, China, Indonesia, Hong Kong, Malaysia, Singapore, Korea, Mexico, Argentina and Brazil) an oil price shock has a positive and statistically significant impact on real stock returns at the 5% level in the same month and/or within one month. By contrast, an oil price shock has a negative and statistically significant impact on real stock returns for U.K, France, Italy, Sweden, Switzerland and Japan.

Future research efforts, which could eliminate some of the limitations of this study, could also investigate i) the effect of such structural oil-market shocks on real stock returns through disaggregated industry or plant level data for a panel of countries, ii) the presence of structural breaks that take into consideration turbulent times and war events, iii) the validity of the decomposition methodology when more risk factors are allowed to play their role as well, iv) the validity of the decomposition methodology (without and with more risk factors) regarding exclusively stocks related to oil firms, and v) the symmetry of oil price shocks for different industries and individual firms. The empirical findings will prove extremely useful to investors who need to understand the exact effect of international oil price changes on certain stocks across industries as well as for the managers of certain firms who need a more thorough evaluation about the efficiency of hedging policies affected by oil price changes.

Appendix A. Data sources

Monthly data over 1997.1 to 2009.8.

Nominal oil price: IMF data from IFS. U.K. Brent (11276AADZF).

U.S.

Stock price index: MSCI (Morgan Stanley Capital International) indices

Short-term interest rate: FRED (Federal Reserve Economic Data). 3 month Treasury-bill (TB3MS),

Producer Prices Index: FRED. Producer Price Indexes All commodities (PPIACO).

Countries: U.K, Canada, Belgium, Denmark, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Russia, China, Japan, Hong Kong, Malaysia, Singapore, Thailand, Indonesia, Korea, Argentina, Brazil, Mexico.

Exchange Rate: FRED. Number of units of currency per U.S. dollar.

Producer Price Index: OECD. Data from Main Economic Indicators (2000=100) for European countries and IMF data from IFS for Asian and American countries.

Stock price index: MSCI (Morgan Stanley Capital International) indices in U.S. dollar price for all countries.

Short-term interest rate: OECD data from Main Economic Indicators for European countries and IMF data from IFS (Treasury Treasury-bill rate) for Asian and American countries.

Bibliographie

* Alizadeh, A.H., Nomikos, N.K., Pouliasis, P.K., 2008. A Markov regime switching approach for hedging energy commodities. Journal of Banking & Finance 32, 1970–1983.
* Baillie, R., Bollerslev, T., Mikkelsen, H., 1996. Fractionally integrated generalized autoregressive conditional heteroskedasticity. Journal of Econometrics 74, 3–30.
* Bjornland, H.C., 2008. Oil price shocks and stock market booms in an oil exporting country. Working Paper 16. Norges Bank, Norway.
* Bollerslev, T., 1986. Generalised autoregressive conditional heteroskedasticity. Journal of Econometrics 31, 307–327.
* Ciner, C., 2001. Energy shocks and financial markets: nonlinear linkages. Studies in Non-Linear Dynamics and Econometrics 5, 203–212.
* Davies, R.B., 1987. Hypothesis testing when a nuisance parameter is present only under the alternative. Biometrika 64, 247–254.
* Driesprong, G., Jacobsen, B., Benjiman, M., 2003. Striking oil: Another puzzle? Working Paper, Erasmus University Rotterdam.
* El-Sharif, I., Brown, D., Burton, B., Nixon, B., Russell, A., 2005. Evidence on the nature and extent of the relationship between oil prices and equity values in the UK." Energy Economics 27, 819–830.
* Engle, R.F., Lilien, D.M., Robins, R.P., 1987. Estimating time varying risk premia in the term structure: the ARCH-M model. Econometrica 55, 391–407.
* Engle, R., 1982. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica 50, 987–1007.
* Fama, E.F., 1981. Stock returns, real activity, inflation, and money. American Economic Review 71, 545–565.
* Faff, R.W., Brailsford, T.J., 2000. A test of a two-factor 'market and oil' pricing model. Pacific Accounting Review 12, 61–77.
* Fong,W.M., See, K.H., 2002. A Markov switching model of the conditional volatility of crude oil futures prices. Energy Economics 24, 71–95.
* Giot, P., Laurent, S., 2004. Modelling daily value-at-risk using realized volatility and ARCH type models. Journal of Empirical Finance 11, 379–398.
* Hamilton, J.D., 1983. Oil and the Macroeconomy since World War II. Journal of Political Economy 91, 228–248.
* Hamilton, J.D., 1996. This is what happened to the oil price–macroeconomy relationship. Journal of Monetary Economics 38, 215–220.
* Hamilton, J.D., 2003. What is an oil shock? Journal of Econometrics 113, 363–398.
* Huang, R.D., Masulis, R.W., Stoll, H.R., 1996. Energy shocks and financial markets. Journal of Futures Markets 16, 1–27.
* Hooker, M., 1999. Exploring the Robustness of the Oil Price–Macroeconomy Relationship. Federal Reserve Board (FEDS) Working paper, 1999-43.
* Hong, H., Torous, W., Valkanov, R., 2002. Do industries lead the stock market? Gradual diffusion of information and cross-asset return predictability. Working Paper, Stanford University and UCLA.
* Sadorsky, P., 1999. Oil price shocks and stock market activity. Energy Economics 21, 449–469.
* Park, J.W., Ratti, R.A., 2008. Oil price shocks and stock markets in the U.S. and 13 European countries, Energy Economics, pp 2587-2608.
* Jones, C.M., Kaul, G., 1996. Oil and the stock market. Journal of Finance 51, 463–491.

* Jorion, P., 1997. Value-at-Risk: The New Benchmark for Controlling Market Risk. McGraw-Hill, Chicago.
* Lee, K., Ni, S., Ratti, A., 1995. Oil shocks and the macroeconomy: the role of price variability. Energy Journal 16, 39–56.
* Mork, K.A., 1989. Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. Journal of Political Economy 97, 703–708.
* Nandha, M., Faff, R., 2008. Does oil move equity prices? A global view. Energy Economics 30, 986–997.
* Narayan, P.K., Narayan, S., 2007. Modelling oil price volatility. Energy Policy 35, 6549–6553.
* Nelson, D., 1991. Conditional heteroskedasticity in asset return: a new approach. Econometrica 59, 347–370.
* O'Neil, T.J., Penm, J., Terrell, R.D., 2008. The role of higher oil prices: A case of major developed countries. Research in Finance 24, 287–299.
* Papapetrou, E., 2001. Oil price shocks, stock market, economic activity and employment in Greece. Energy Economics 23, 511–532.
* Pollet, J., 2002. Predicting asset returns with expected oil price changes. Working Paper Harvard University.
* Chen, N.F., Roll, R., Ross, S.A., 1986. Economic forces and the stock market. Journal of Business 59, 383–403

Appendix 1

Figure 1: Oil price returns (Brent)

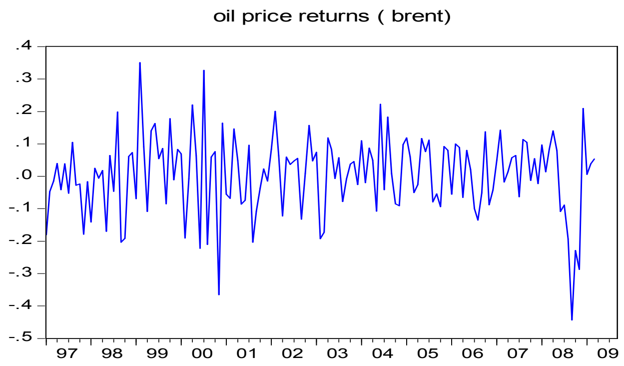
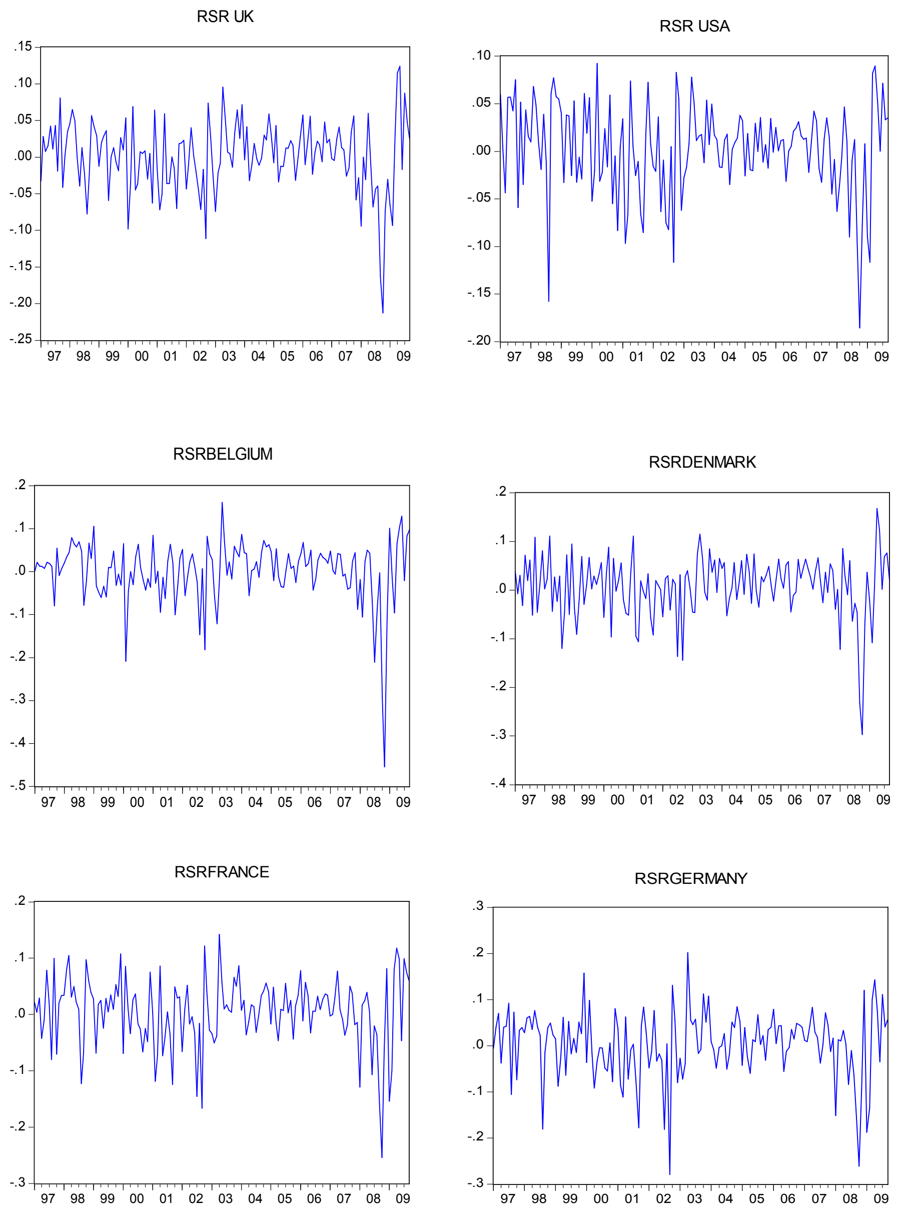
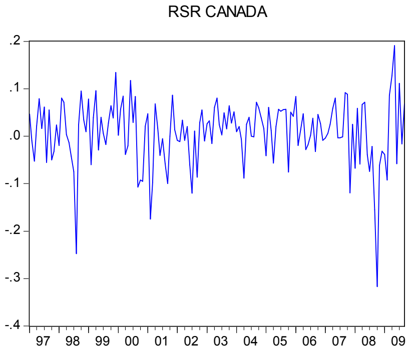
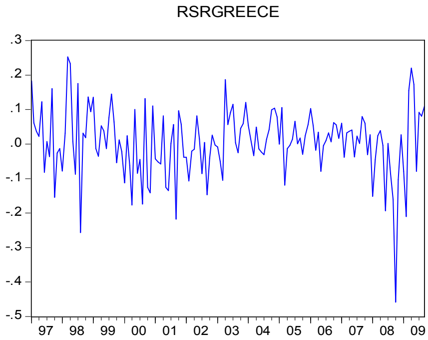
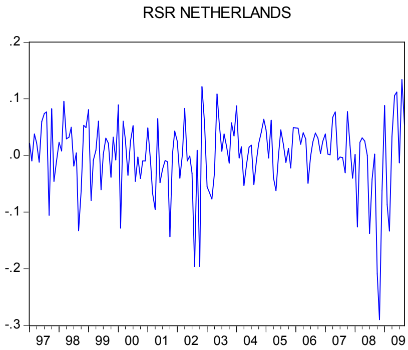


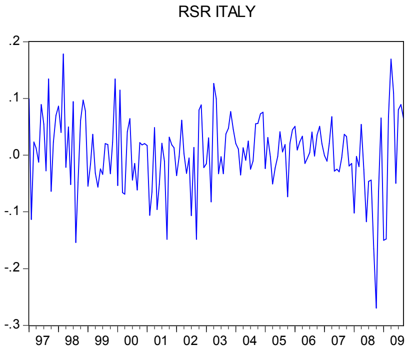
Figure 2: stock market returns: Mature and Emerging Markets

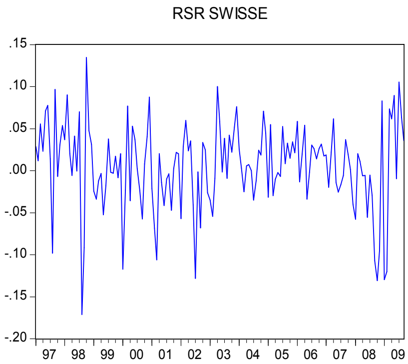


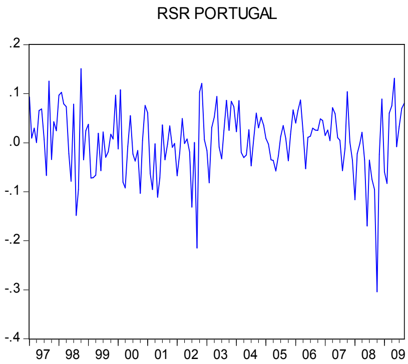

RSR CANADA
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09

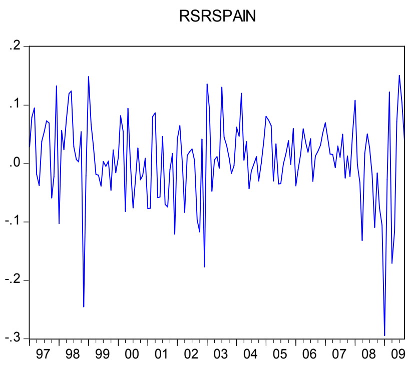

RSRGREECE
.3
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
97 98 99 00 01 02 03 04 05 06 07 08 09

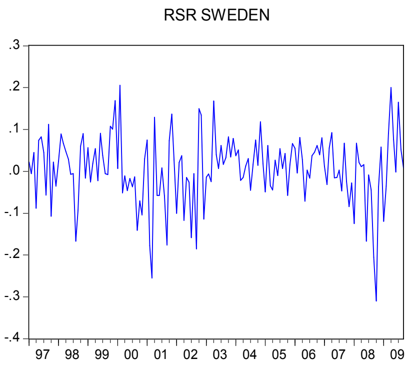

RSR NETHERLANDS
.2
.1
.0
-.1
-.2
-.3
97 98 99 00 01 02 03 04 05 06 07 08 09

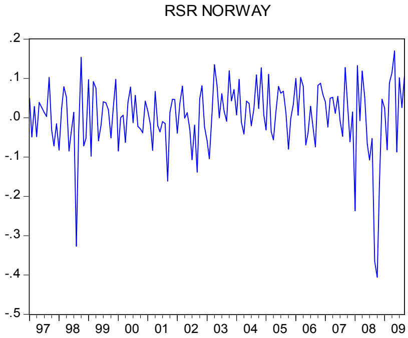

RSR ITALY
.2
.1
.0
-.1
-.2
-.3
97 98 99 00 01 02 03 04 05 06 07 08 09

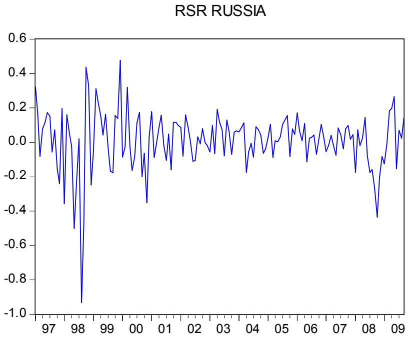

RSR SWISSE
.15
.10
.05
.00
-.05
-.10
-.15
-.20
97 98 99 00 01 02 03 04 05 06 07 08 09

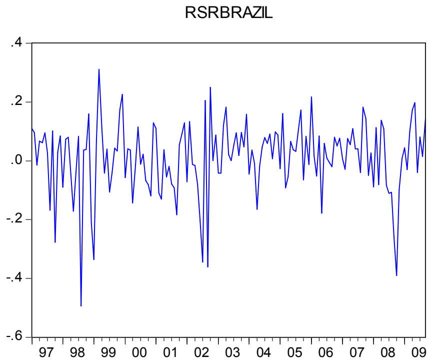

RSR PORTUGAL
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09

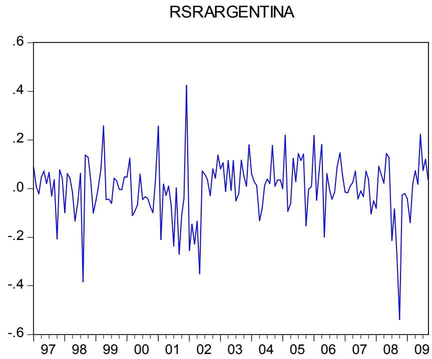

RSRSPAIN
.2
.1
.0
-.1
-.2
-.3
97 98 99 00 01 02 03 04 05 06 07 08 09

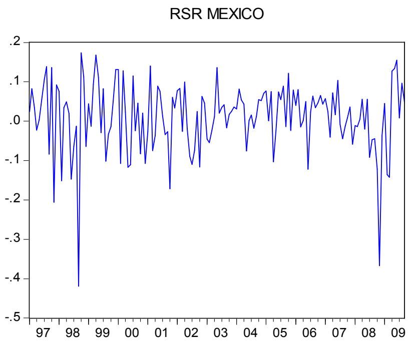

RSR SWEDEN
.3
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09

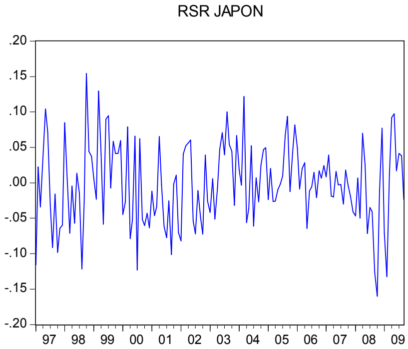

RSR NORWAY
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
97 98 99 00 01 02 03 04 05 06 07 08 09

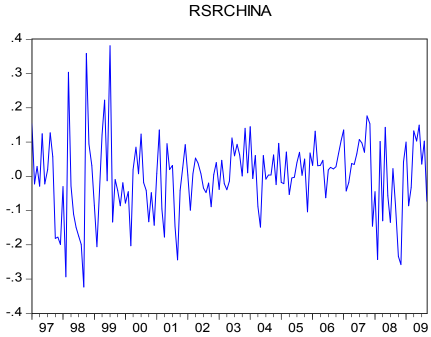

RSR RUSSIA
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
97 98 99 00 01 02 03 04 05 06 07 08 09

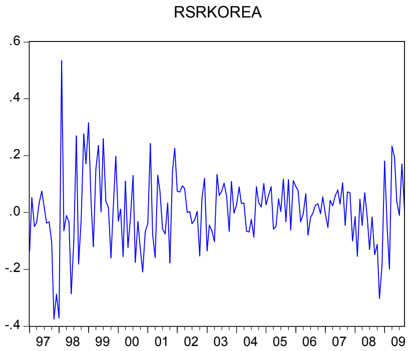

RSRBRAZIL
.4
.2
.0
-.2
-.4
-.6
97 98 99 00 01 02 03 04 05 06 07 08 09

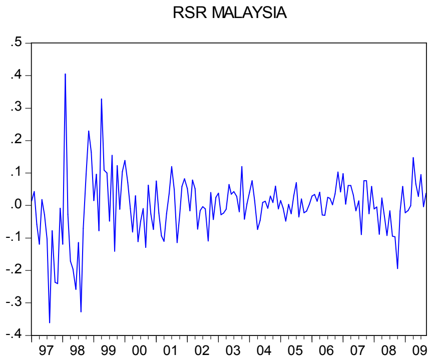

RSRARGENTINA
.6
.4
.2
.0
-.2
-.4
-.6
97 98 99 00 01 02 03 04 05 06 07 08 09

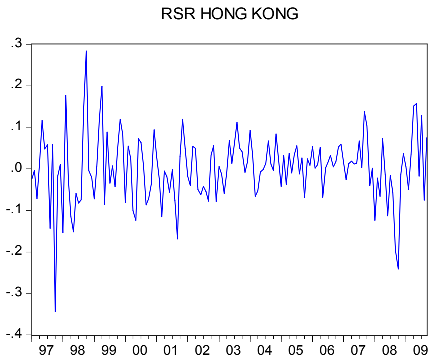

RSR MEXICO
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
97 98 99 00 01 02 03 04 05 06 07 08 09

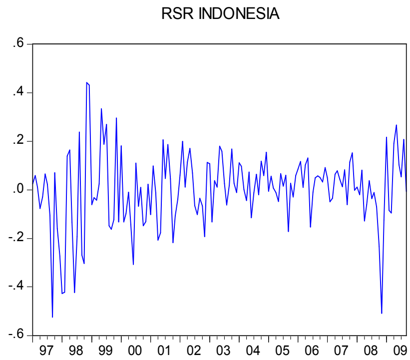

RSR JAPON
.20
.15
.10
.05
.00
-.05
-.10
-.15
-.20
97 98 99 00 01 02 03 04 05 06 07 08 09

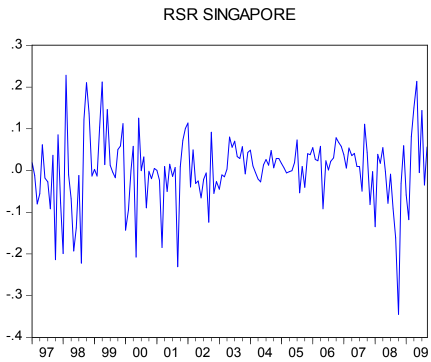

RSRCHINA
.4
.3
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09

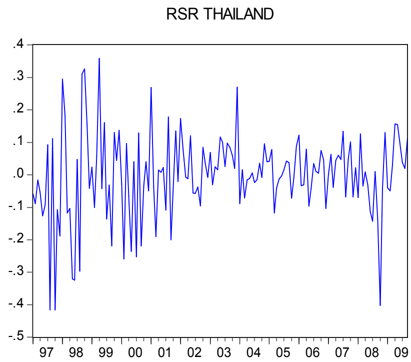

RSRKOREA
.6
.4
.2
.0
-.2
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09


RSR MALAYSIA
.5
.4
.3
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09


RSR HONG KONG
.3
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09


RSR INDONESIA
.6
.4
.2
.0
-.2
-.4
-.6
97 98 99 00 01 02 03 04 05 06 07 08 09


RSR SINGAPORE
.3
.2
.1
.0
-.1
-.2
-.3
-.4
97 98 99 00 01 02 03 04 05 06 07 08 09


RSR THAILAND
.4
.3
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
97 98 99 00 01 02 03 04 05 06 07 08 09

Appendix 2
Figure 3: oil price Volatility and stock market returns

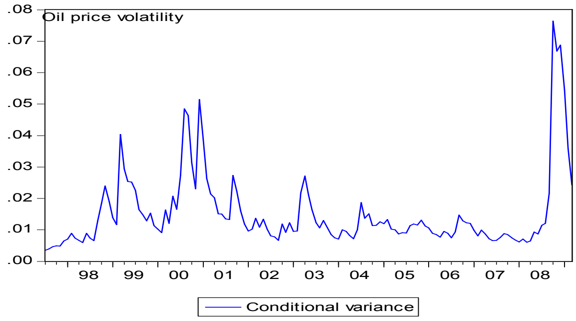
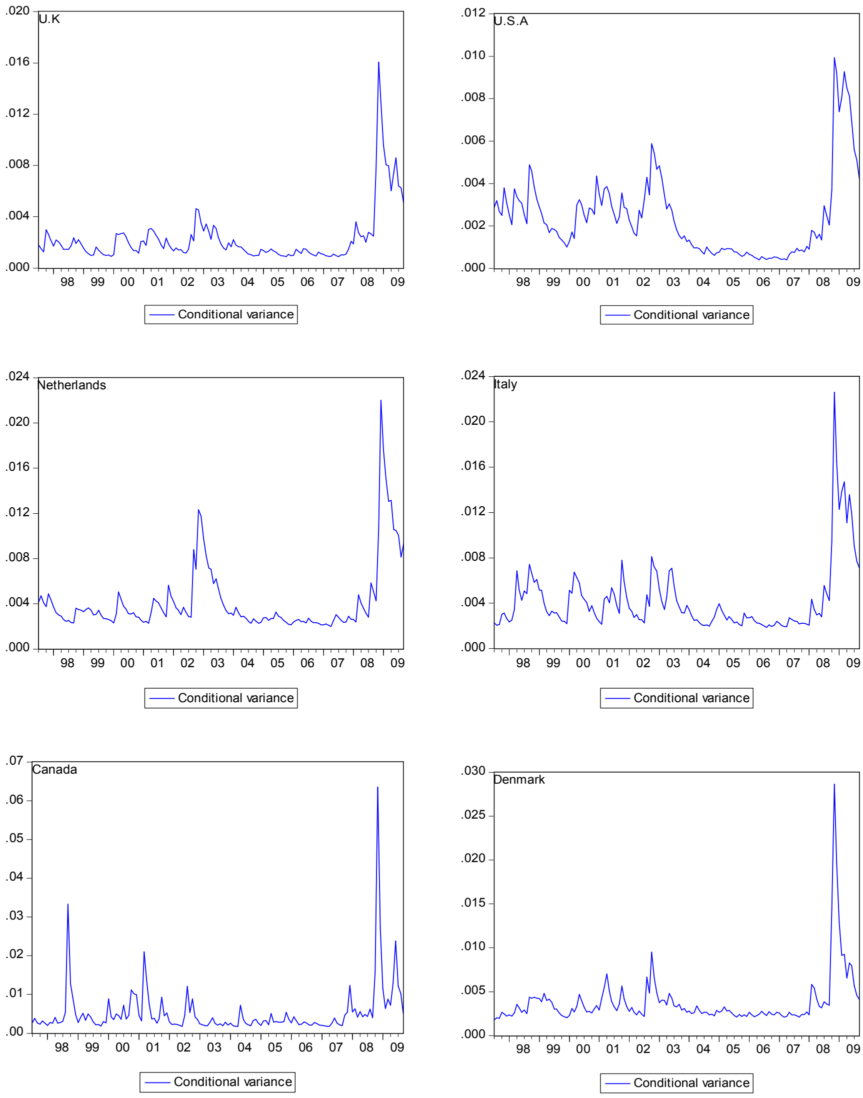
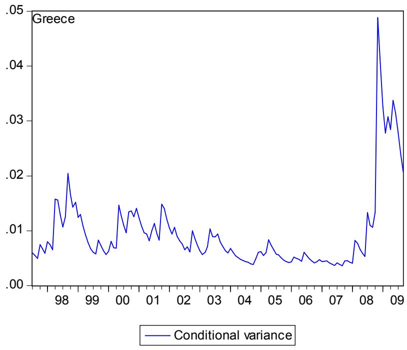
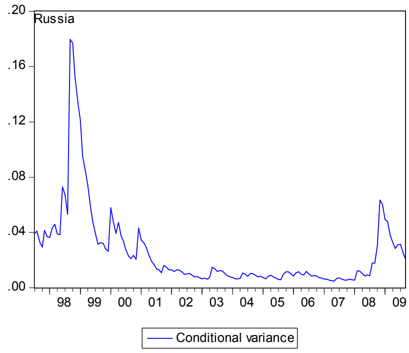
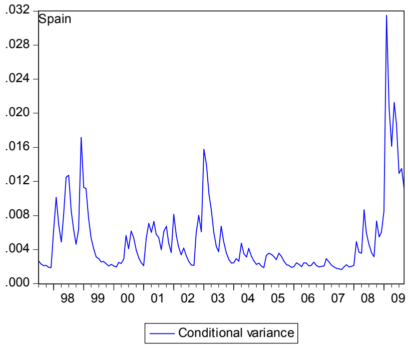


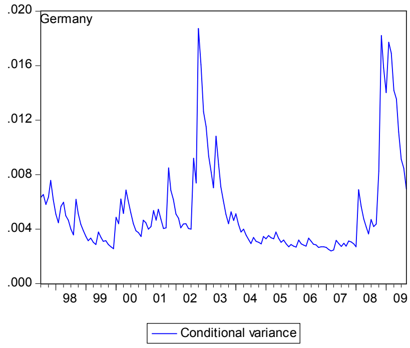
Figure 4: Volatility stock market returns

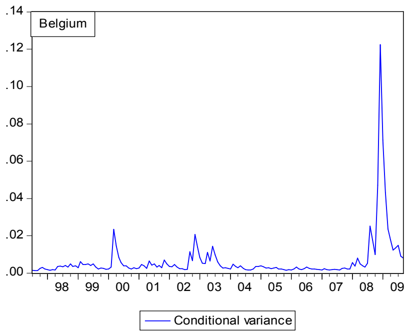


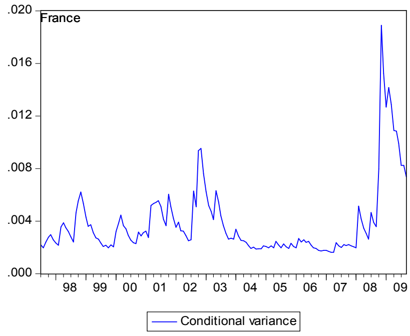

Greece
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

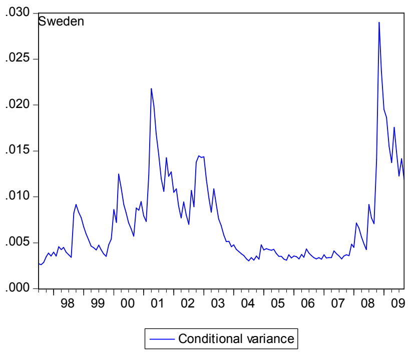

Russia
.20
.16
.12
.08
.04
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

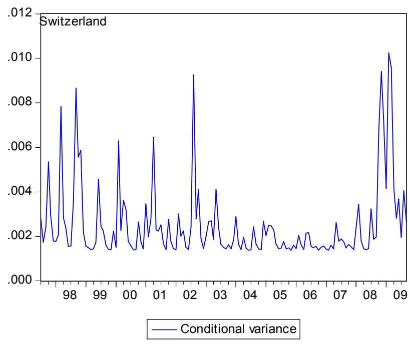

Spain
.032
.028
.024
.020
.016
.012
.008
.004
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

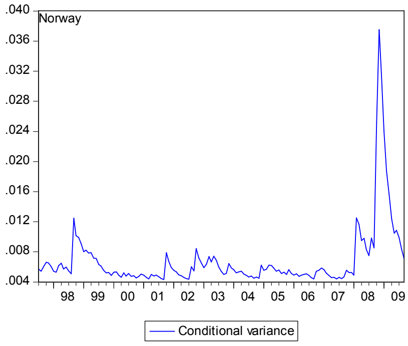

Germany
.020
.016
.012
.008
.004
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

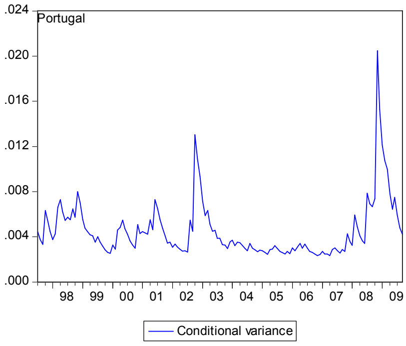

Belgium
.14
.12
.10
.08
.06
.04
.02
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

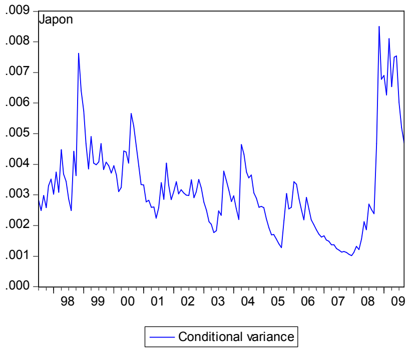

France
.020
.016
.012
.008
.004
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

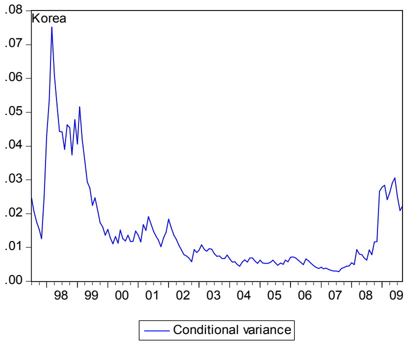

Sweden
.030
.025
.020
.015
.010
.005
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

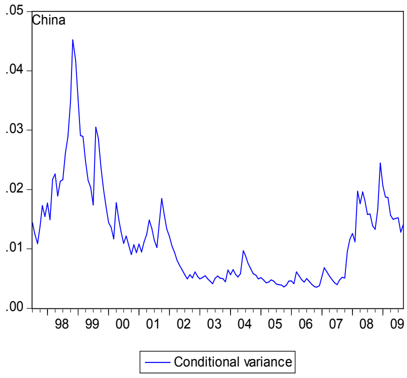

Switzerland
.012
.010
.008
.006
.004
.002
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

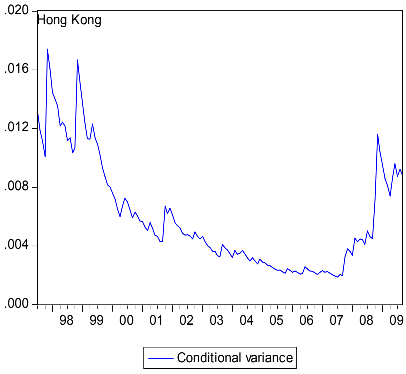

Norway
.040
.036
.032
.028
.024
.020
.016
.012
.008
.004
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

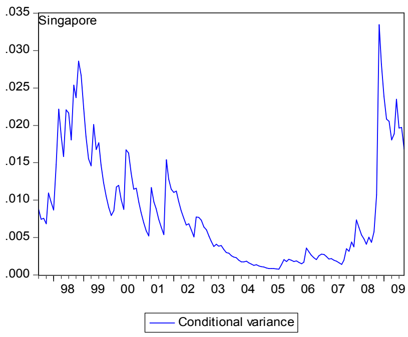

Portugal
.024
.020
.016
.012
.008
.004
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

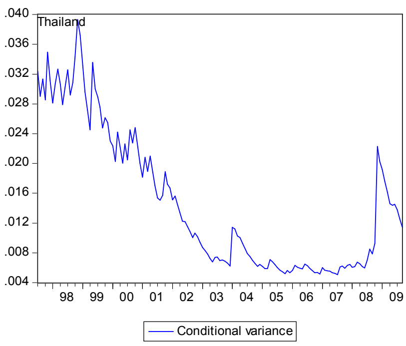

Japon
.009
.008
.007
.006
.005
.004
.003
.002
.001
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

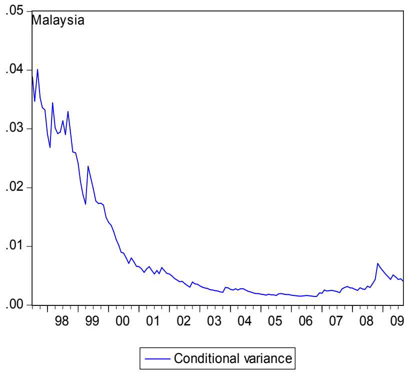

Korea
.08
.07
.06
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

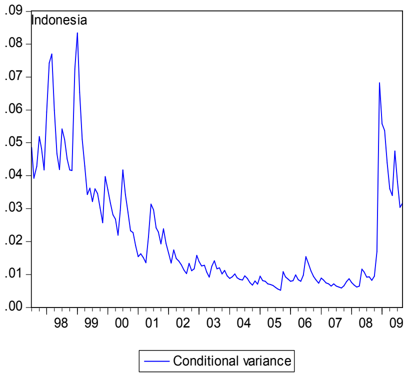

China
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

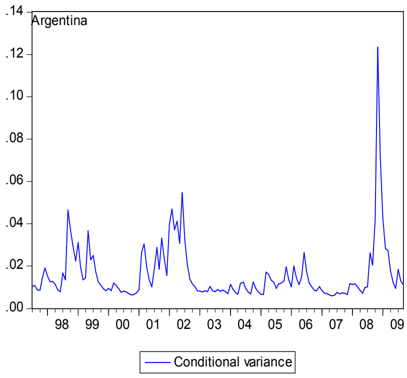

Hong Kong
.020
.016
.012
.008
.004
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

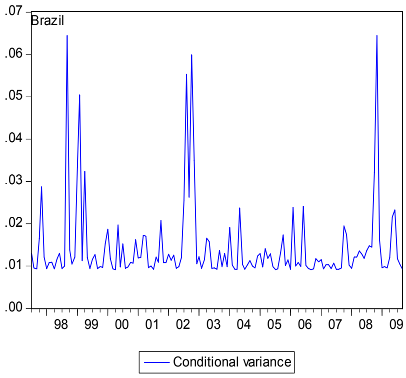

Singapore
.035
.030
.025
.020
.015
.010
.005
.000
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance

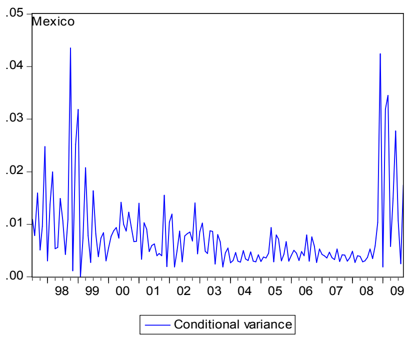

Thailand
.040
.036
.032
.028
.024
.020
.016
.012
.008
.004
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance


Malaysia
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance


Indonesia
.09
.08
.07
.06
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance


Argentina
.14
.12
.10
.08
.06
.04
.02
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance


Brazil
.07
.06
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance


Mexico
.05
.04
.03
.02
.01
.00
98 99 00 01 02 03 04 05 06 07 08 09
Conditional variance