Oil Price Shocks and Stock Market Performance in Emerging Economies: Some Evidence using FAVAR Models

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Oil Price Shocks and Stock Market Performance in Emerging Economies: Some Evidence using FAVAR Models *

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Abstract

This paper examines the response of real stock prices to oil price shocks for four selected emerging economies over the period January 1991–March 2011. To overcome the problem of omitted information in small-scale vector autoregression (VAR) models, we utilize the factor augmented vector autoregressive (FAVAR) approach proposed by Bernanke et al. (2005). Accordingly, we follow Stock and Watson (2002b) and extract two factors which are significantly related with a large set of world-level and country-specific macroeconomic variables. We use the extracted factors as regressors in recursive VARs to assess the response of stock prices to oil price shocks. Our results suggest that the response of stock prices to oil price shocks is quite persistent and precise, but asymmetric across all the four economies. Specifically, we observe that stock prices in Brazil and India respond negatively to oil price shocks, whereas the response of stock prices to oil price shocks in China is positive. We also observe that stock prices in Russia initially respond positively, however, the response becomes negative after four months. The impulse-response results indicate that the impact of oil price shocks on stock prices is smaller for China than that of for remaining three countries. Overall, our results suggest that the use of FAVAR approach allows us to obtained more coherent evidence on the effects of oil price shocks on stock prices by obtaining relatively more precise responses and by increasing the understanding of such shocks from the theoretical point of view.

JEL classification: G1, Q4
Keywords: emerging economies; stock prices, oil price shocks, FAVAR

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1 Introduction

Despite numerous studies have extensively investigated oil price effects on macroeconomic performance, the literature on the response of stock market to oil price shocks is still growing. Several researchers have shown that oil price dynamics significantly affect a number of macroeconomic activities. In particular, studies, such as Hamilton (1983), Mork et al. (1994), Lardic and Mignon (2008), Lescaroux and Mignon (2008), and Hamilton (2009a) have provided evidence of significant and negative effects of oil prices on GDP growth. Some studies have also shown that an increase in oil prices is likely to provide inflationary effects, see Cologni and Manera (2008). Hamilton (2003, 2005) shows that nine out of ten recessions in the US have been preceded by oil price shocks. Further, empirical research including Hamilton (1983), Daniel (1997), and Carruth et al. (1998) has also rejected the hypothesis that the relation between oil prices and output is just a statistical coincidence, by proving significant evidence on the oil price effects.

Another strand of studies has argued that oil price affects the performance of stock market through its impact on the macroeconomy. A common intuition emerging from these studies is that since oil is one of the important production factors, any oil price increase will lead to increase production costs (Arouri and Nguyen, 2010; Backus and Crucini, 2000; Kim and Loungani, 1992). The higher cost will pass to the consumers, resulting higher consumer prices. These inflationary pressures lower aggregate demand including consumption and investment spending, deteriorate consumer sentiment, and thus, in turn, would lead slowdowns in overall economic activities (Bernanke, 2006; Abel, 2001; Hamilton, 1988, 1996, 2011; Barro, 1984). Clearly, stock markets tend to respond negatively in such economic downturns (Sadorsky, 1999; Jones and Kaul, 1996).

The relationship between oil prices and stock markets can also be explained as follows. According to economic theory, the price of any asset should be determined by the discounted value of expected future cash flows associated with it (Fisher, 1930; Williams, 1938). Therefore, it is expected that any factor that could affect the discounted value of cash flows of assets may have a significant influence on prices of these assets. In this context, any increase in oil prices should result in a decline of stock prices. This is because higher oil prices would increase costs of production, which would result to decrease firms' earnings, and in a sequence this would reduce the firms' value. In this case, any hike in the oil price would cause a reduction in equity prices.

However, the effect of oil prices on stock prices can be the opposite for oil-exporting countries. In particular, oil price increases would not only increase earnings of those firms that produce oil but also increase the country's income. These increases in income are expected to bring a rise in consumer spending and investments and thus productivity and the level of employment, which would, in turn, enhance the performance of the stock markets (see Filis et al., 2011; Bjørnland, 2009; Jimenez-Rodriguez and Sanchez, 2005).

Another channel through which oil price would have an effect on stock markets is the uncertainty that oil price dynamics create to the financial markets (Doran and Ronn, 2008; Ramey and Ramey, 1991; Friedman, 1977). Volatilities in inflation rates, arising from oil price shocks, would cause increases in uncertainty concerning variations in future prices, distort price signals and thus reduce the efficiency of the overall economic system. These all are expected to have an inverse impact on the performance of stock market. As a result, there is a negative relationship between stock prices and oil shocks. Oil price shocks can impact a firm's share prices through its impact on the investment behaviour of the firm as well. In fact, several studies including Glass and Cahn (1987), Mohn and Misund (2009), Elder and Serletis (2009, 2010), Yoon and Ratti (2011), and Henriques and Sadorsky (2011) have documented statistically significant impacts of oil price uncertainty on firms' investment decisions. One can also predict a positive impact of oil price shocks on stock market performance. Oil price shocks lead to increasingly large economic risk (Hamilton, 1983). Since high risk is considered as an instrument of achieving higher economic growth, economies with high variance are also likely to have high growth on an average. In this context, oil price shocks are expected to be positively related to stock market performance (Black, 1987).

The nature of the response of stock markets to oil price shocks, however, would also depend on origins of the shocks. In particular, the market would react positively to the oil shocks those originate from the demand side.[1] On the other hand, stock markets would respond negatively

[1] Wang et al. (2013) argue that the magnitude, duration, and even direction of response by stock market returns to oil market shocks in a country highly depend on whether the country is a net importer or exporter

if the shocks originate from the supply side. For more on the nature of oil price shocks and their effects, see Kilian (2009) and Hamilton (2009b).

On empirical grounds, there are several studies that have examined the impact of oil prices on stock market returns. At best, the findings of these studies are mixed. For instance, Jones and Kaul (1996) study the relationship between real oil prices and real stock returns for the US, Canada, Japan, and the UK using quarterly data. They find a significant negative impact of oil price on real stock returns for all four countries.[2] However, Chen et al. (1986) examine the effects of oil price on stock market returns along with a variety of macroeconomic factors. They use monthly data for the US, covering the period 1953-1983. They show that there is no statistically significant effect of oil price on stock returns.

Likewise, Driesprong et al. (2008) do a comprehensive study of the effect of oil prices on stock returns. Their empirical investigation is based on monthly data for the period October 1983-April 2003. Their sample includes 18 developed and 30 developing countries. They find a negative and statistically significant effect of oil prices on stock market returns for 17 out of 18 developed countries. They also find a negative relationship between oil prices and stock returns for developing countries. Nonetheless, they document that the relationships are not statistically significant for most of developing countries. Jammazi and Aloui (2010) and Apergis and Miller (2009) also show that there is no significant relationship between oil prices and the performance of stock market.

Narayan and Sharma (2011) examine the effect of oil price on stock returns using daily time series data for the period 5 January 2000 to 31 December 2008 for 560 US firms. They find that there is a statistically significant effect of oil price on firm returns. However, they show that this effect varies across industries. Further, their analysis shows that there is a significant lagged effect of oil prices on stock returns. Filis et al. (2011) examine the effect of oil prices on stock returns for three oil-exporting countries, namely Canada, Mexico, and Brazil, and three oil-importing countries, namely the US, Germany, and the Netherlands. Their study is based on monthly data. They find a negative relationship between oil prices and stock market

in the world oil market.

[2]Several other studies, such as Filis (2010), Chen (2010), Miller and Ratti (2009), Nandha and Faff (2008), and Ciner (2001), have also shown a negative relationship between oil price and stock returns.

returns for all countries. They also show that while the correlation of the two markets increases in response to demand-side oil price shocks, the relationship is not affected by supply-side oil price shocks. Similarly, Arouri and Nguyen (2010) examine the impact of oil prices on stock returns for European countries, and they find that oil prices have a tendency to exercise a statistically significant effect on stock market index returns.

Several other studies have also examined the response of stock returns to oil price shocks. For instance, Lee and Chiou (2011) examine the response of S&P returns to WTI oil prices and find that large variations in oil prices have a statistically significant impact on stock returns. However, they find that small variations in oil prices have a statistically insignificant effect on S&P returns. Similarly, Cifarelli and Paladino (2010) examine the effects of oil price on stock returns and exchange rates. They find that fluctuations in oil prices have a statistically significant influence on both stock price and exchange rate changes. Choi and Hammoudeh (2010) also find statistically significant correlations among Brent oil, WTI oil, gold, silver, and stock prices in the US. Another study by Chang et al. (2012) examine S&P500, Dow Jones, NYSE, and FTSE100 stock indices response to variations in crude oil markets, namely Brent and WTI.

Arouri and Rault (2012) and Basher and Sadorsky (2006) study how stock markets of GCC countries response to oil price fluctuations. They find a positive and statistically significant effect of positive oil price shocks on stock market performance. Several other studies have also reported a statistically significant response of stock markets to oil price shocks. For example, among others, see Sadorsky (1999), Nandha and Faff (2008), Lardic and Mignon (2008), Park and Ratti (2008), Hamilton (2009a,b), Oberndorfer (2009), Kilian and Park (2009), Kilian (2009), and Chen (2010), who report that oil price shocks (either supply- or demand-side) have a significant impact on stock prices. In particular, Chen (2010) examines whether increased oil price leads stock market recessions. His empirical analysis is based on monthly data covering the period January 1957-May 2009 for S&P stock index. He finds that higher oil prices increase the likelihood of the stock market to be in the bear territory. Park and Ratti (2008) study the response of stock markets of the US and 13 European countries to oil price volatility and oil price shocks. They show that there is a significant impact of oil price shocks on stock returns. However, Kilian and Park (2009) provide evidence of differential effects of oil price shocks on the real stock returns of the US depending on the nature of the shocks. Nandha and Faff (2008) examine the impact of oil price rises on stock returns using data for 35 industrial sectors, and they find higher oil prices have a negative impact on stock returns for all sectors with an exception of mining, and oil and gas industries. Chiou and Lee (2009) estimating an autoregressive conditional jump intensity model conclude that variations in oil price have a significant negative effect on the stock returns of the US. Sadorsky (1999) also provides evidence of a significant influence of oil price volatility on stock returns.

On the other hand, several studies have shown that the effect of oil price shocks on stock prices is statistically insignificant. For example, Al-Fayoumi (2009) shows that there is no statistically significant association between oil price shocks and stock market performance. Similarly, Al Janabi et al. (2010) find that GCC stock markets are more efficient in terms of information than oil prices. This implies that informations concerning oil prices cannot be used to predict these stock markets. Nordhaus (2007) points out that the effect of oil price shocks turns statistically insignificant in several countries because of the greater wage flexibility. The similar picture is painted by Blanchard and Gali (2007), suggesting that oil price shocks do not have significant impact on stock markets' performance.

In exploring the impacts of oil price and oil price shocks on stock returns, most of prior studies have mainly relied on either standard vector autoregression (VAR) models or ARCH/GARCH models. Since these methods do not perform efficiently with large numbers of variables, they restrict researchers to consider only a limited number of variables in the estimation. In particular, the VAR procedure assumes that the relevant information set for the identification of the oil price co-movement is summarized by its lagged values. However, additional information available concerning other domestic and international macroeconomic indicators not included in the VAR may be relevant to the dynamics of oil prices and stock returns. Bearing in mind such limitations of the methods applied previously in this area, in this paper, we examine how oil price shocks influence stock market performance by applying the factor augmented vector autoregression (FAVAR) approach proposed by Bernanke et al. (2005). The FAVAR approach enables us to over come the problem of omitted information of a small-scaled VAR model by including more information into the specification. Our empirical analysis is based on monthly data covering the period from January 1991 to March 2011 for four major emerging economies, namely Brazil, China, India, and Russia.

The current paper is the first to apply the FAVAR approach to examine the impacts of oil price shocks on stock returns of four major emerging economies. To the best of our knowledge, none of the existing studies apply the FAVAR procedure to investigate the influence of oil price shocks on stock market performance, although this methodology has been often applied in other literatures. For example, Lescaroux and Mignon (2009) estimate the FARVAR model to investigate the impacts of oil prices on the Chinese economy using 13 variables that cover the period from 1980 to 2006. The study results suggest that an oil price shock leads to a contemporaneous increase in consumer and producer price indexes, inducing a rise in interest rates, a delayed negative impact on GDP, investment and consumption, and a postponed increase in coal and power prices. Bagliano and Morana (2009) investigate the international comovements among a set of key real and nominal macroeconomic variables in the US, UK, Canada, Japan and the Euro area. They present evidence that comovements in macroeconomic variables do not concern only real activity, but are an important feature also of stock market returns, inflation rates, interest rates and, to a relatively smaller extent, monetary aggregates. Another study by Zagaglia (2010) uses a factor augmented vector autoregressive model (FAVAR) to study the dynamics of oil futures prices in the NYMEX.

The FAVAR methodology overcomes several limitations that the standard VAR methodology possesses. In particular, it enables including a large set of variables in the estimation while examining the impact of oil price shocks on stock market performance. Thus, researchers cannot only include domestic factors that are important in formulating the interactions between oil prices socks and stock returns but also the international factors such as world GDP growth and world inflation. Another important feature of the FAVAR is that it allows us to model jointly the dynamics of world-level and country-level variables within a single consistent empirical framework. In that respect, we see our empirical strategy as an improvement over the numerous papers that have compared the impulse responses of stock prices to oil price shocks on the basis of models estimated separately for each country (e.g. Angeloni et al., 2003).

Therefore, we use a data set that involves three common world oil market indicators, major currencies exchange rates, CPI, and percentage change in GDP of both world and emerging economies. In addition, several country-specific factors have also been taken into consideration for each country. Further, we extract two common factors from the data set and augment the main VAR model with these factors to give more information when estimating the effects of oil price shocks on stock prices.

The rest of the paper is structured as follows. Section 2 describes econometric framework that we apply to assess the response of stock prices to oil price shocks. Section 3 discusses the data and conducts the tests to examine the time series properties of the data. Section 4 reports the empirical results. Section 5 concludes the paper.

2 Econometric Methods

2.1 Factor Augmented Vector Autoregression (FAVAR) Model

The basic idea of the model proposed by Bernanke et al. (2005) aims to solve VAR dimensionality problems and allow researchers to utilize a large data set through a small number of unobservable factors.[3] Following Stock and Watson (2002a), we use a large data set, say X_t, to extract two unobservable factors (i.e. $K = 2$), $F_t = [F_{1t}, F_{2t}]$. These factors summarize all additional information that are meant to reflect theoretically motivated concepts such as 'economic activity', 'price pressures', or 'credit conditions', which cannot easily be represented by one or two series but rather are reflected in a wide range of economic variables. In contrast X_t, Y_t denotes a $m - dimensional$ vector of observable economic variables assumed to drive the dynamics of an economy. The joint dynamics of F_t and Y_t evolve according to the following state equation:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + e_t \tag{1}$$

[3] Boivin and Giannoni (2008) and Mumtaz and Surico (2009) extended the econometric framework to include international factors.

where $\phi(L)$ is a comfortable lag polynomial of finite order d, e_t is an error term with mean zero and covariance matrix Σ. In our application, interest rates, exchange rates, stock market prices, and industrial production are assumed to be directly observable and included in vector Y_t, whereas the effect of other domestic and world macroeconomic variables are accounted by the unobservable factors F_t. Equation (1) cannot be estimated without knowledge of F_t.[4] Therefore, a large 'informational data set' X_t can be used to extract common factors using the following observation equation as in Bernanke et al. (2005):

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \tag{2}$$

where X_t is a large data set related to un-observed factors, F_t, and the observed variables Y_t. Λ^f is an $(n \times k)$ matrix of factor loadings, Λ^y is an $(n \times m)$, e_t is an $(n \times 1)$ vector of error terms. Error terms have mean zero, and either normal and uncorrelated or display a small amount of cross-correlation, depending whether estimation is done using likelihood or principal components.[5] If the terms in $\phi(L)$ that relate Y_t to F_t are all zero in equation 1, then it is a standard VAR in Y_t, otherwise the equation, as referred by Bernanke et al. (2005), is a factor augmented vector autoregression (FAVAR) model. If the true system is a FAVAR but instead estimated as a standard VAR, that is, the relevant factors are omitted, then the estimates obtained from the standard VAR system will be biased.

Bernanke et al. (2005) therefore consider two alternative approaches for estimating both observation and the state space equations of the FAVAR model. The first one is a two-step approach proposed by Stock and Watson (2002a). According to this approach, initially, principal components techniques are used to estimate the common factors $\mathbf{F}$, and then the parameters leading the dynamics of the state equation are obtained using standard classical methods for VARs. The second one is a single-step Bayesian likelihood approach. By comparing both methods in the context of an analysis of the effects of monetary policy shocks, Bernanke et al. (2005) find that the two-step approach yields more plausible results. Another advantage of this approach is its computational simplicity. The main advantage of the static representation of the

[4] The list of world and domestic variables used to extract factors are provided in Appendix A.

[5] The principal component estimation allows for some cross-correlation of the error terms that must vanish as N goes to infinity (Stock and Watson, 2002a).

dynamic factor model given by equation (2) is that the factors can be estimated by principal components (see Stock and Watson, 2002a).

Accordingly, the common factors have to be extracted from the large macroeconomic data set previous to estimating the term structure model. As in Bernanke et al. (2005), this is achieved using standard static principal components following the approach suggested by Stock and Watson (2002a). In particular, let V denote the eigenvectors corresponding to the k largest eigenvalues of the $T \times T$ cross-sectional variance-covariance matrix XX' of the data set. Then, subject to the normalization $F'F/T = I_k$ estimates $\hat{F}$ of the factors and $\hat{L}$ the factor loadings are given by:

$$\hat{F} = \sqrt{T}V \tag{3}$$

$$\hat{\Lambda} = \sqrt{T}X'V \tag{4}$$

2.2 Data

We employ monthly data covering the period from January 1991 to March 2011, for a total of 243 observations for each series.[6] In our case, the vector Y_t comprises exchange rates, interest rates, share price indices, industrial production indices, and spot prices for WTI crude oil traded in the New York Mercantile Exchange (NYMEX).[7] In our implication, X_t corresponds to the data set used for the extraction of the common factors. It embodies 29 time series variables that are meant to capture world and each country specifications separately. World-level variables include gold prices, major currencies exchange rates, oil production, oil stocks, consumer price index (CPI) and gross domestic product changes for both emerging region and overall world. Country specifications are covering the exports, imports, country consumer price index, country producer price index and the foreign exchange rate.[8] Our focus is to apply real oil price shocks and analyse the impact on each country stock market price. Therefore, we deflated nominal oil price used in Y_t using US consumer price index: for all urban consumers, all items, to construct real prices. Oil prices in the NYMEX respond (to some extent) to the global supply and

[6]Russia sample starts from January 1998 to March 2011.

[7]Industrial production index for Brazil is not available.

[8]The complete list of the series, the sources and the choice of filtering are reported in Table 6 in Appendix A.

demand factors. Hence, the data set includes series that are available from Energy Information Administration (EIA) on world crude oil production and stocks. It is important to stress that the data on crude oil stocks refer only to what is known as primary stocks.[9] The complete list of the series, the sources and the choice of filtering are reported in Table 6 in Appendix A. As standard in the literature, all series transformed to be stationary, if necessary. The series have been demeaned and standardized before extracting the principal components.

3 Empirical Results

3.1 Preliminary Tests

Before presenting empirical results relating to the response of stock prices to oil price shocks, we present summary statistics of world-level macroeconomic indicators as well as country-specific macroeconomic variables included in the analysis. Table 1 reports descriptive statistics for world indicators, while summary statistics of the variables for each country is reported in Table 2. Specifically, the tables present the mean, standard deviation, minimum, and maximum values of the underlying variables. The mean of log oil prices over the examined period is 3.570, while the average value of log gold prices is 6.188. The standard deviation estimates suggest that the oil prices appear more volatile than gold prices over the period under study. The mean world GDP growth is 2.316, while the mean of log world CPI is 4.342. The value of US dollar with respect to Australian dollar is more variable as compared to its value against Japanese yen and UK pound.

Looking at the descriptive statistics of country-specific variables we observe that among all the four emerging countries, the log value of stock prices on an average is higher in China followed by India. However, stock prices are less volatile in India as compared to other three countries. It should also be noted that in all the four economies, the fluctuations in stock prices are higher than variations in oil prices during the sample period. We also observe that there are significant differences between all the four countries with respective to other variables. For example, India has lowest interest rate on an average with the mean value of 1.187, while this

[9]Primary stocks encompass crude oil stocks in refining and storage facilities of the industry, such as crude oil in export and import terminals, in distribution terminals, in refinery columns, and in specific large storage facilities.

figure is 3.738 for Brazil. The mean log CPI of each country is approximately similar to that of for whole world, with an exception of Brazil where the inflation on an average is less. However, the standard deviation of log CPI suggests that month-to-month changes in CPI for three out of the four economies are higher than that of for the whole world. We also note that, on an average, India has higher industrial production compared to other three countries included in the sample.

In the next step, we apply the modified Dickey-Fuller t test for a unit root (known as the DF-GLS test) proposed by Elliott et al. (1996) in order to identify the order of integration of each time series. The results at levels as well as at first differences for world indicators and country-specific variables are reported in Tables 3 and 4, respectively. The Akaike Info Criterion (AIC) is applied to select the optimal lag order for Dickey-Fuller GLS regressions. We also consider a linear time trend in the series while testing for unit roots. The estimates given in Table 3 provide evidence that all the word-level indicator variables are non-stationary at their levels. However, all the indicators appear stationary at their first differences. The results in Table 4 demonstrate that almost all of the country-specific variables follow unit root at their levels. However, CPI in China and PPI in Russian appear stationary at their levels, while all the other country-specific variables are integrated of order one as they appear stationary at their first differences. The order of integration of each variable helps us in applying transformation method when estimating the FAVAR model to extract the factors from the data set.

3.2 Factor Estimation

To estimate the FAVAR given by equation (1), we first need to estimate the unobserved factors F_t. Due to the size of our data set, we extract two factors only for each country. The data set used to extract these factors, X_t, consists of two main parts, world-level macroeconomic variables and country-specific macroeconomic variables. We treat the first part (world indicators) as common for all countries, where the second part is unfixed and changed according based on each country domestic variables. It should be noted that the extracted factors have therefore no structural interpretation. It is interesting to know to what extent both extracted factors provide similar information of the large data set, X_t. To answer this question, we estimate correlation coefficient for each country. The estimated correlation coefficients are very low and appears statistically insignificant, providing evidence that both the factors are not correlated.[10]

In order to provide some preliminary evidence on the role of factors and information they convey, we examine the correlation between the extracted factors and the other variables included in the data set. Specifically, we first select the world indicators and country-specific variables based on correlations between the variables and each extracted factor for each country. We then regress each of the highest correlated macroeconomic variables on each of the factors separately to estimate the share of total variation explained by each factor. The estimation results are given in Table 5. The estimated values of R^2 reveal that the common extracted components (factor) explain a significant portion of the variance of most of the variables for all countries. For example, in case of Brazil, we obtain an R^2 of 62.3%, 57.1%, 46.7% , and 37.5% for CPI, PPI, the exchange rate between Australian dollar and US dollar (AUD/USD), and the exchange rate between UK pound and US dollar (GB/USD), respectively. Similarly, for China, the estimated value of R^2 is 72.8%, 70.9%, and 52.4% for imports, exports, and the exchange rate between Australian dollar and US dollar (AUD/USD), respectively. In case of Russia, the variables for which the extracted factors explain an important proportional of the variance are imports (57.6%), exports (57.0%), and the exchange rate between UK pound and US dollar (GB/USD) (37.7%). For India, the obtained values of R^2 suggest that the exchange rate between UK pound and US dollar (GB/USD), the exchange rate between Australian dollar and US dollar (AUD/USD), imports and exports are highly related with the extracted factors. Further, we observe that the significant portion of the variance of gold prices and GDP of emerging economies are also explained by the extracted common factors for all the countries. However, we also observe that there are also some variables for which the obtained R^2 is small (e.g. oil stock), suggesting that the extracted factors do not significantly explain the variance of these variables. Overall, the estimates given in Table 5 suggest that both the extracted common factors significantly explain the portion of variance of both world-level macroeconomic indicators and country-specific variables.

[10]Correlation estimates are not provided here to economize the space, however, are available from the authors.

3.3 Analysing Oil Price Shocks

After confirmation of the order of integration of each series and association between the extracted factors and the other variables included in the data set, we estimate the effects of oil price shocks on real stock prices. Specifically, we augment the VAR model by including the two common factors extracted from a relatively large data set in order to over come the omitted information problem of the standard VAR model. The obtained generalized impulse response results are illustrated in Figures 1-4. Specifically, the figures contain the estimates of the impact of oil price shocks on stock prices, exchange rates, interest rates, and industrial production. Overall, the figures reveal that the impulse-response functions are generally significant statistically and seem to make sense from the theoretical point of view. However, the effects of oil price shocks considerably differ across all the four emerging economies. For instance, the reactions of stock prices to oil price shocks in both Brazil and India are negative and appear very persistent. In particular, they do not die off even after 20 months. This implies that oil price shocks have a significant and long-lasting effect on stock market performance. Further, the persistent nature of the responses suggest that the authorities of these emerging markets should take some measures to remove the unfavourable effects of oil shocks on stock market performance.

The impulse-response functions depicted in Figure 3 suggest that stock prices react positively to oil price shocks in China. Although this positive response is relatively slow, it seem permanent. Interestingly, stock prices in Russian initially respond positively to oil price shocks. However, after 4 months, it becomes negative. The negative response of Russian stock market to oil price shocks is at its highest level at one year after getting the shocks. However, after this it starts to decline. We also observe that stock prices react faster to oil price shocks in India and Russia in comparison to both Brazil and China. The figures also depict that the effects of oil price shocks on stock market performance are larger for Brazil and Russia as compared to the other two countries. In particular, this difference seems more pronounced after 9 months of the occurring of a oil price shock. Overall, the impulse-response functions indicate that stock prices significantly respond to oil price shocks in all of the four emerging economies. However, the effects of oil price shocks are asymmetric across the economies.

Although the main focus of this paper is to assess the effects of oil price shocks on stock prices, it is useful to look at the response of some other variables to oil price shocks. In particular, we observe the response of exchange rates, interest rates, and industrial production.[11] Similar to the case of stock prices, the response of these variables are asymmetric across all the four countries. Specifically, the results suggest that the effects of oil price shocks on exchange rates are negative for Brazil and China, whereas these effects are positive in case of India. Nevertheless, the effects seem very persistent and do not die off over the examined horizons for both India and China. By contrast, the response of the exchange rate in Brazil declines over the time and then almost completely die off at a 20-month horizon. In case of Russia, the impulse-response function of the exchange rate indicates an initial negative effect of oil price shocks on exchange rates (up to a 8-month period) turning to a positive effect, but then dying off quickly.

The response of interest rates to oil price shocks is also asymmetric across the examined emerging economies. In particular, the reaction of interest rates to oil price shocks for Brazil is negative up to three horizons, however, after this it turns positive. On the other hand, in case of India and Russia, the interest rate reacts to oil price shocks negatively initially, then positively, but then it gain responds negatively. In contrast to these cases, the reaction of the interest rate to oil price shocks is positive through out the horizons in case of China. These responses are in line with theoretical expectations. It is also worth noting that the effects of oil price shocks on interest rates are smaller than the effects of oil price shocks on both stock prices and exchange rates. The results also suggest that the response of industrial production to oil price shocks is negative through out the time horizons for India. Whereas, for China and Russia, the response of industrial production to oil price shocks is positive and significant statistically, but then it turns negative, suggesting that the impacts of oil price shocks on industrial production change over time.

Overall, we consider our results to be satisfactory. The impulse-response functions obtained are generally accurate and seem to make sense from an economic point of view. We also think that we obtain the consensual evidence on the impact of oil price shocks on stock price in emerg-

[11]Since data on industrial production index for Brazil is not available, we observe the response of oil price instead of industrial production.

ing economies. Nevertheless, our empirical findings are naturally not free from problems. In particular, the results we presented here can be improved by including more macroeconomic-level variables into the data set. It should also be considered the country-specific-microeconomic-level variables. Other econometric instruments such as variance decomposition would also be applied to better and more precise interpretation of the results and for a comparison purpose.

4 Conclusions and Policy Implications

There has been much interest in the recent energy economic literature on the response of stock prices to oil price/production shocks. Most of prior studies have examined this issue in vector autoregression (VAR) frameworks. However, the documented findings are mixed at best. One of the questions arise over whether the estimates of the response of stock prices to oil price shocks based on small-scale VAR models suffer from omitted information problems as such models allow research to include only a limited number of variables in the specification. Another question of the interest is that whether the response of stock prices to oil shocks differs across emerging and rapidly growing countries. This paper amid at providing answers to these questions.

Specifically, to overcome the problem of omitted information in small-scale vector autoregression (VAR) models, in this paper, we combines the VAR methodology with dynamic factor analysis and examine the response of stock prices to oil shocks for four selected emerging economies, namely Brazil, China, India, and Russia. Our empirical analysis covers the period January 1991-March 2011. Specifically, we use the data set that involves three common world oil market indicators, major currencies exchange rates, world CPI, gold prices, and percentage change in GDP of both world and emerging economies. In addition, we also take into account several country-specific variables, such as interest rates, consumer and producer price indices, exports and imports, and industrial production, for each country when estimating the response of stock prices to oil price shocks.

Using the factor augmented vector autoregressive (FAVAR) approach proposed by Bernanke et al. (2005), we extract two factors which are significantly related with a large set of world-level and country-specific macroeconomic variables. We use the extracted factors as regressors in recursive VARs to assess the response of stock prices to oil price shocks. Unlike the standard VAR model, the FAVAR approach allows us to include larger dimensional datasets.

Our results suggest that the impulse responses of stock prices to oil prices shocks are quite persistent and accurate, but asymmetric across all the four examined emerging economies. Specifically, we observe that stock prices in Brazil and India respond negatively to oil price shocks, whereas the response of stock prices to oil price shocks in China is positive. We also observe that stock prices in Russia initially respond positively, however, the response becomes negative after four months. Finally, the impulse response results reveal that the impact of oil price shocks on stock prices is smaller for China than that of for remaining three countries. Overall, our results suggest that the use of the FAVAR approach allows us to obtained more coherent evidence on the effects of oil price shocks on stock prices by obtaining relatively more precise responses and by increasing the understanding of such shocks from the theoretical point of view.

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Figure 1: The Impulse Response of Stock Prices to a shock in Oil Price: The Case of Brazil

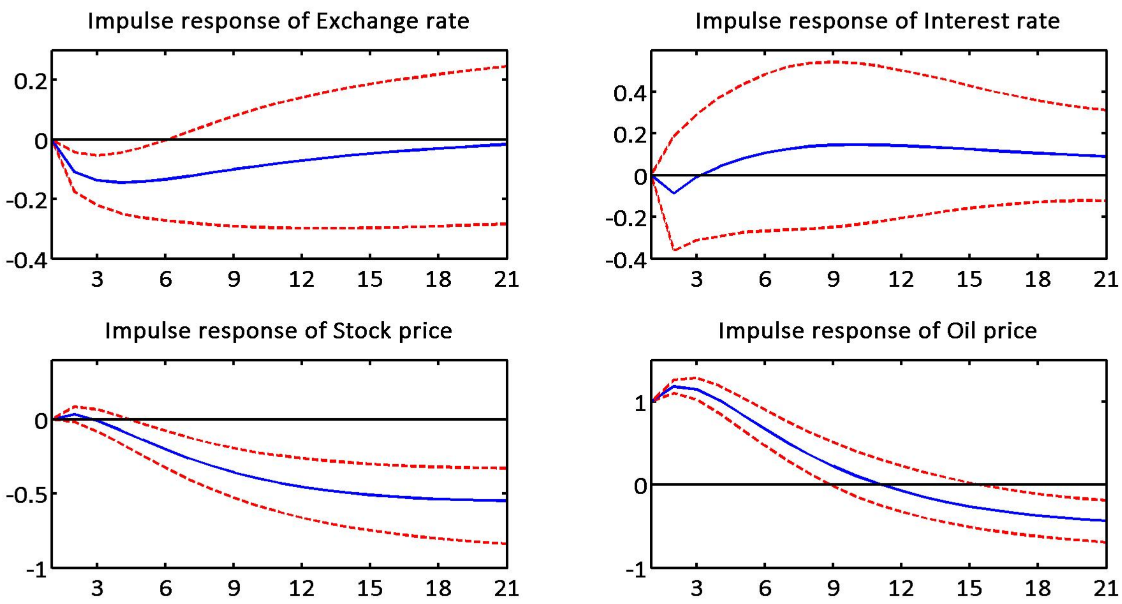

Figure 2: The Impulse Response of Stock Prices to a shock in Oil Price: The Case of India

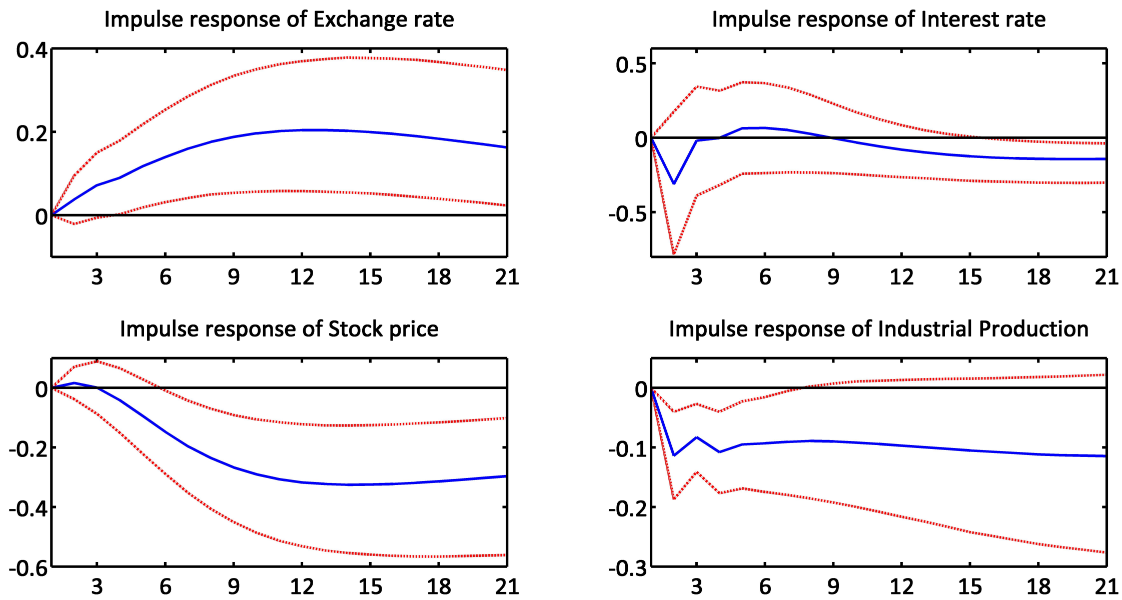

Figure 3: The Impulse Response of Stock Prices to a shock in Oil Price: The Case of China

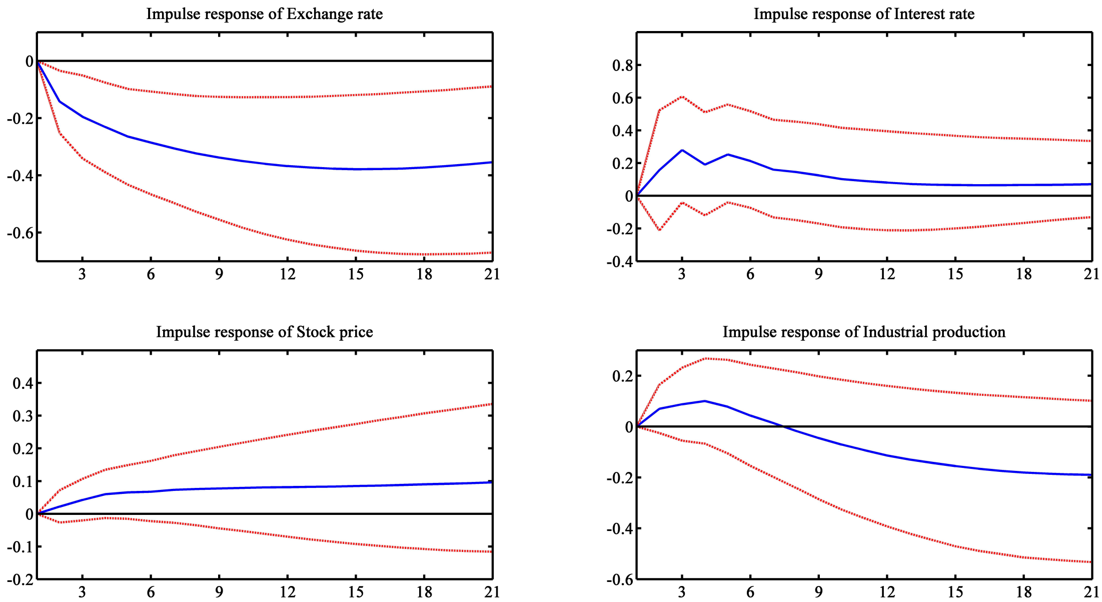

Figure 4: The Impulse Response of Stock Prices to a shock in Oil Price: The Case of Russia

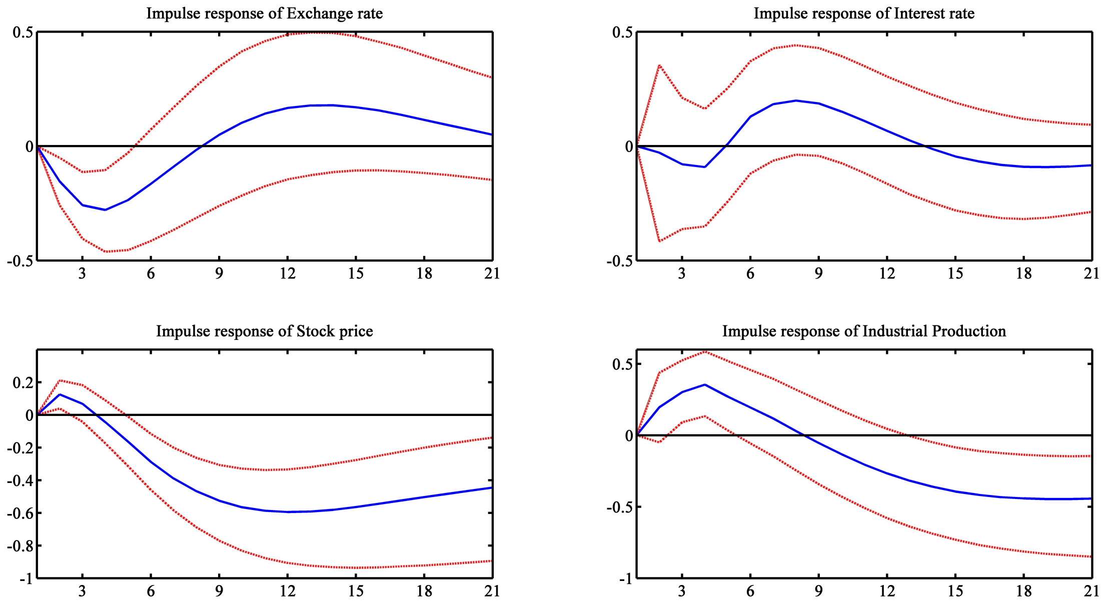

Table 1: Summary statistics: World indicators

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
World					
lop	243	3.570	0.478	2.600	4.779
lgp	243	6.188	0.360	5.650	7.132
laex	243	-0.334	0.160	-0.715	0.0324
lbex	243	-0.501	0.096	-0.729	-0.339
ljex	243	4.711	0.124	4.389	4.967
lcos	243	6.843	0.073	6.714	6.997
lcop	243	11.120	0.074	10.985	11.229
lcpiw	243	4.342	0.384	3.351	4.821
gdpem	243	4.815	2.901	-3.773	9.442
gdpw	243	2.316	3.323	-8.183	5.389

Table 2: Summary statistics: Country-specific variables

Variable	Obs	Mean	Std. Dev	Min	Max
Brazil					
lex	243	-0.133	2.657	-9.115	1.639
lir	243	3.738	1.831	2.158	9.513
lsp	243	2.825	3.347	-7.936	5.559
lexp	243	7.893	0.346	7.142	8.564
limp	243	7.684	0.516	6.880	8.732
lfex	243	10.888	0.824	8.727	12.640
lcpi	243	3.263	2.706	-5.911	4.884
lppi	243	3.032	2.851	-6.453	4.938
India					
lex	243	4.027	0.230	3.274	4.338
lir	243	1.987	0.623	-0.158	4.382
lsp	243	4.252	0.715	2.602	5.650
lexp	243	8.422	0.798	7.119	10.323
limp	243	5.411	1.081	3.099	7.341
lfex	243	10.673	1.411	6.890	12.628
lcpi	243	4.383	0.377	3.573	5.090
lppi	243	4.377	0.323	3.666	4.962
lipi	243	4.347	0.398	3.675	5.222
China					
lex	243	2.375	0.153	1.950	2.582
lir	243	1.534	0.507	0.993	2.346
lsp	243	4.723	0.729	2.300	6.234
lexp	243	10.197	1.022	8.119	11.945
limp	243	10.070	0.996	8.012	11.933
lfex	243	12.366	1.484	9.846	14.929

cpi	243	4.828	6.699	-2.675	27.697
lipi	243	2.618	0.404	0.742	3.503
Russia					
lsp	159	4.183	1.120	1.273	5.590
lex	159	3.615	0.365	2.093	3.977
lir	159	1.735	0.908	0.000	4.939
ppi	159	1.512	2.320	-8.371	7.427
lcpi	159	4.404	0.563	2.906	5.166
lexp	159	9.636	0.650	8.433	10.765
limp	159	9.161	0.700	7.993	10.358
lfex	159	11.096	1.441	8.800	13.275
lipi	159	4.545	0.173	4.154	4.822

Table 3: Unit root test results: World indicators

Variables	**Without trend**	**With trend**	**Without trend**	**With trend**
	level		**difference**	
lop	-1.108(1)	-2.141(1)	-7.823(1)***	-8.629(1)***
lgp	1.542(1)	0.370(1)	-6.074(2)***	-12.319(1)***
laex	-0.768(1)	-0.948(1)	-6.082(2)***	-7.309(2)***
lbex	-1.274(1)	-1.913(1)	-0.888(7)	-3.379(2)***
ljex	-0.032(1)	-1.755(1)	-0.829(8)	-3.087(6)***
lcos	-0.393(1)	-1.458(1)	-2.698(7)***	-9.500(1)***
lcop	0.068(1)	-1.948(1)	-10.870(1)***	-12.675(1)***
lcpiw	-1.025(13)	0.444(13)	-4.166(1)***	-3.531 (2)***
gdpw	-2.792(12)	-2.752(12)	-7.775 (2)***	-7.775(2)***
gdpem	-2.579(1)	-2.657 (1)	-10.707 (1)***	-10.673(1)***

*** Significance at the 1 % level.

Table 4: Unit root test results: Country-specific variables

Variables	Without trend (level)	With trend (level)	Without trend (difference)	With trend (difference)
Brazil				
lsp	0.553(4)	-0.707(4)	-3.773(3)***	-3.879(3)***
lex	0.186(3)	-0.624(3)	-3.072(2)***	-4.046(2)***
lir	-0.543(1)	-2.266(1)	-1.236(1)	-2.930(1)**
lppi	-0.132 (2)	-1.233(2)	-2.239(1)**	-3.705(1)**
lcpi	-0.213(1)	-1.348(1)	-1.774(1)*	-3.712(1)**
lexp	-0.340(12)	-2.178(13)	-3.241(3)***	-5.599(3)***
limp	-0.565(1)	-2.455(1)	-2.430(2)***	-5.741(2)***
lfex	1.165(1)	-1.183(1)	-0.963(2)	-3.099(2)**
India				
lsp	0.954(1)	-2.790(1)	-2.706(4)***	-7.613(1)***
lex	1.153(1)	-0.690(1)	-8.260(1)***	-10.509(1)***
lir	-2.376(2)**	-3.475(2)**		
lppi	5.293(1)	-1.025(1)	-3.152(2)***	-6.479(1)***
lcpi	1.866(12)	-1.352(12)	-3.210(3)***	-5.422(3)***
lexp	2.723(12)	-0.716(12)	-3.047 (4)***	-5.509(4)***
limp	3.175(1)	-2.250(1)	-2.652(3)***	-4.721(3)***
lfex	2.596(2)	-1.415(3)	-3.918(2)***	-5.704(2)***
lipi	1.317(14)	-1.597(14)	-2.472(4)**	-3.478(4)***
China				
lsp	0.329(1)	-1.480(1)	-10.207(1)***	-10.340(1)***
lex	-0.501(1)	-1.122(1)	-9.309(1)***	-9.885(1)***
lir	-0.040(1)	-1.183(1)	-9.914(1)***	-9.940(1)***
cpi	-2.702(7)***	-2.615(7)**		
lexp	1.690(13)	-2.416(13)	-7.650(5)***	-5.911(5)***
limp	2.195(13)	-2.001(13)	-7.849(6)***	-4.403(6)***
lfex	3.399(1)	-1.462(1)	-2.999(4)***	-4.812(4)***
lipi	-1.763(3)	-2.589(3)	-15.071(2)***	-15.066(2)***
Russia				
lsp	0.602(1)	-2.117(1)	-6.820(1)***	-6.878(1)***
lex	0.741(1)	-1.519(1)	-6.652(1)***	-7.176(1)***
lir	-1.414(1)	-3.070(1)	-7.265(1)***	-8.785(1)***
ppi	-6.518(1)***	-6.634(1)***		
lcpi	3.519(1)	-0.999(1)	-5.694(1)***	-6.281(1)***
lexp	0.545(12)	-2.143(12)	-5.196(6)***	-5.012(6)***
limp	-0.317(12)	-2.082(12)	-4.610(5)***	-4.823(5)***
lfex	1.021(3)	-1.532(3)	-2.114(3)**	-4.239(2)***
lipi	-1.772(2)	-1.768(2)	-9.069(2)***	-8.127(2)***

*** Significance at the 1 % level.

** Significance at the 5 % level.

Table 5: Share of explained variance of highly correlated series

Variable	**Factor 1**	**Factor 2**
	R^2	R^2
Brazil		
aex	0.467	
bex	0.375	
gp	0.357	
gdpem	0.171	
exp	0.155	
cpi		0.623
ppi		0.571
gdpem		0.206
India		
bex	0.474	
aex	0.460	
fex	0.260	
gp	0.253	
gdpem	0.179	
exp		0.441
imp		0.354
ppi		0.218
gdpw		0.177
China		
exports	0.709	
imports	0.728	
gdpem	0.270	
gdpw	0.130	
oilst	0.087	

austus		0.524
gbus		0.363
gold		0.358
Russia		
imports	0.5761	
exports	0.5706	
austus	0.2367	
cpi	0.2192	0.3148
gdpem	0.2017	
gbus		0.3769
austus		0.3238

Appendix A: Description of dataset

The variables used in this study are obtained from International Monetary Fund (IMF), except those variables which are meant to energy are obtained from Energy Information Agency (EIA). All nominal prices deflated using US-CPI: all urban, all products. Transformation to stationary has been done based on unit root test results. Tcode column show the transformation method used for each variable, where; 1- at level, 2- log of level, 3- first difference of logs, 4- first difference of level.

Table 6: Dataset Description

No.	Series Title	Unit	Tcode
	World macroeconomic factor		
1	Gold Price	US Dollars per onze	3
2	Total Crude Oil Stocks	Million Barrels	3
3	Crude Oil Production, World	Thousand Barrels per Day	3
4	Consumer Price Indices, World	Index	3
5	GDP Volume, % Change, for Emerging & Developing Economies	Percent %	3
6	GDP Volume, % Change, World	Percent %	3
7	Japanese Yen in terms of US Dollars	YEN/USD	3
8	Great Britten Pounds in terms of US Dollars	GB/USD	3

Table 6 – Continued

No.	Series Title	Unit	Tcode
9	Australian Dollar in terms of US Dollars	AUD/USD	3
	Country specific factor		
India			
10	National CPI	Index	3
11	Exchange rate	National Currency per US Dollars	3
12	Interest rate	Percent per Annum	1
13	Share price	Index	3
14	Industrial production	Index	3
15	Producer price index (PPI)	Index	3
16	Total imports	Millions US Dollars	3
17	Total exports	Millions US Dollars	3
18	Foreign exchange		3
Brazil			
19	National CPI	Index	3
20	Exchange rate	National Currency per US Dollars	3

Table 6 – Continued

No.	Series Title	Unit	Tcode
21	Interest rate	Percent per Annum	4
22	Share price	Index	3
23	Industrial production	Index	3
24	Producer prices	Index	3
25	Total imports	Millions US Dollars	3
26	Total exports	Millions US Dollars	3
27	Foreign exchange	Millions US Dollars	3
China			
28	National CPI	Index	2
29	Exchange rate	National Currency per US Dollars	3
30	Interest rate	Percent per Annum	4
31	Share price	Index	3
32	Industrial production	Index	3
33	Producer prices	Index	3
34	Total imports	Millions US Dollars	3

Table 6 – Continued

No.	Series Title	Unit	Tcode
35	Total exports	Millions US Dollars	3
36	Foreign exchange	Millions US Dollars	3
Russia			
37	National CPI	Index	3
38	Exchange rate	National Currency per US Dollars	3
39	Interest rate	Percent per Annum	4
40	Share prices	Index	3
41	Industrial production	Index	3
42	Producer price	Index	2
43	Total imports	Millions US Dollars	3
44	Total exports	Millions US Dollars	3
45	Foreign exchange	Millions US Dollars	3