Short-run and long-run oil price sensitivity of Chinese stocks

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Abstract

Using a GMM approach and five different return measurement intervals, this study examines the oil price sensitivity of 29 Chinese stock market sectors. Results show that over the sample period May 1994 to October 2009, the Chinese stock market returns exhibited a positive sensitivity to oil price. This appears to contradict the economic logic that hikes in oil prices would usually have a negative impact on the profitability of corporations and hence their share prices. Perhaps this could be an implication of the increased energy demand induced by high economic growth in China whereby oil prices and economic growth move side by side. Further, half yearly return measures appear to capture the oil price sensitivity of Chinese stock returns much better than the weekly or monthly return measurements. Consequently, Chinese stocks could be an attractive destination for hedging against the oil price hikes.

Key words: oil price, sensitivity, China stock market.
JEL Classification: G12, Q43.

1. Introduction

Identifying the forces that drive stock market returns is an issue of utmost importance in finance. The Intertemporal Capital Asset Pricing Model described by Merton (1973) suggests that macroeconomic variables are likely to have some influence on asset returns and there are various theories (see Mandelker and Tandon, 1985; Boudoukh and Richardson, 1993) that propose linkage between the macroeconomic variables and stock market returns. Indeed, macroeconomic variables are often used to proxy for pervasive risk factors in the context of Asset Pricing Models (Chen, Roll and Ross, 1986). Among these macroeconomic variables, oil ranks under the category of most important resources in the economy and appears to play a crucial role in setting the economic policies (Brychcy, 2006).

Oil is special in a sense that it fuels most of the transportation worldwide and is a feedstock for pharmaceuticals, agriculture, plastics and a myriad of other products used in everyday life. As countries urbanize and modernize their demand for oil increases significantly (Basher and Sadorsky, 2006). Energy, financial markets and the economy are all explicitly linked together on a country's path of economic growth. Adelman (1993, p.537) writes: "Oil is so significant in the international economy that forecasts of economic growth are routinely qualified with the caveat: 'Provided there is no oil shock'." Mork et al (1994) surveys a large body of related academic research and find a significant impact of oil price shocks on economic output. Since asset returns are inextricably linked to the expected cash flows, it is plausible to suggest that future realizations of macroeconomic factors influence asset returns through information about future cash flows (Pollet, 2004). On theoretical grounds, oil-price shocks affect stock market returns or prices through their effect on expected earnings (Jones et al., 2004). Considering that traders from all over the world can observe oil prices on a real

time basis and at almost no cost, one would expect that information in oil prices is precisely and immediately reflected in the stock prices. There are various studies (see Appendix 1) which have explored the influence of oil prices on stock markets. However, there appears no consensus among the findings of existing studies and thus more studies on this topic make a logical sense.

This study is focused to explore the impact of oil prices on the Chinese market and aims to provide further insights into the linkages between oil prices and stock markets. Specifically, we examine:

a. Whether stock market returns in China show any sensitivity to oil price changes?
b. How the oil price sensitivity (if any) behaves among various Chinese stock market sectors?
c. Does short or long term returns measure reflect any systematic difference in the oil sensitivity estimates?

A brief discussion highlighting the significance of the oil for the Chinese economy and growth in the Chinese stock market is presented in section 2. Section 3 is devoted to literature review whereas the data and methodological issues are covered under section 4. Section 5 is reserved for a discussion of results followed by conclusions in section 6.

2. Oil and the Chinese economy

China continues playing a major role in both the supply and demand sides of the global economy. International Energy Outlook (IEO) 2010 projects an average annual growth rate of approximately 5.8 percent for China's economy from 2007-2035-the highest among all the

world's economies. China is the world's most populous country and the second largest energy consumer behind the United States. China's share of world energy consumption is going to reach 25% by the year 2035, which is expected to be highest among any single country[1].

Rising oil consumption (Table 1) have made China a significant factor in world oil markets. China consumed an estimated 8.2 million barrels per day of oil in 2009, making the second-largest oil consumer in the world behind United States. China's net oil imports were approximately 3.9 million barrels per day in 2008, making it the third-largest net oil importer in the world behind the United States and Japan.

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Insert Table 1

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China's national oil companies are currently planning or building several new refineries and upgrading existing plants. Recently, offshore oil exploration in China has been the greater focus of the oil majors. All these activities are indicators of high significance of oil for the Chinese economy. Figure 1 shows that the oil consumption in China and the Chinese GDP are closely connected. More specifically, their correlation over the study period was 0.9608 which is very high by all standards.

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Insert Figure 1

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A country's stock market is usually considered a barometer for economic growth, thus one would expect the high connectivity between the oil consumption and GDP (a measure of

[1] http://www.eia.gov/oiaf/ieo/pdf/0484%282010%29.pdf (Accessed October 2010)

economic activity) be translated in terms of oil prices and stock market movements. A visual view of oil price and Chinese stock market movements (Figure 2) appears to indicate as if the oil price and Chinese stock market are synchronised.

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Insert Figure 2

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The launch of the Shanghai Stock Exchange and the Shenzhen Stock Exchange in 1990 marked the formation of a national stock market in China which has grown at a rapid pace. The number of listed stocks has increased from 291 in 1994 to 1625 by the end of 2008. Similarly, the aggregate market capitalization has grown from $5.6 billion to more than $810 billion (see Table 1). In terms of market capitalization, the Chinese stock market is now among the largest in the Asia-Pacific region after Japan. At the end of 2008, shares held by the 534 thousand institutional investor accounts made up 54.6% of the total free-float market capitalization. This reflected a fundamental change in China's stock investor composition, which had been dominated by retail investors for a long time (CSRC report 2008)[2].

Considering China is one of the fastest growing economies in the world, China's fast expanding corporate sector and stock market are rapidly integrating with the global economy through large amounts of foreign direct investment, its recent membership to the World Trade Organization (WTO), the introduction of the Qualified Foreign Institutional investor (QFII) scheme, and the increasing number of Chinese firms seeking listing status overseas (Yuan et al, 2008). The rapid development of Chinese stock markets and its fast emerging corporate sector provides an improved opportunity for diversification by foreign investors. This further underpins the significance of our study.

[2] http://www.csrc.gov.cn/pub/csrc_en/about/annual/200907/P020090701496625000834.pdf

3. Literature review

Economic growth is tied to stable supplies of crude oil (Salameh, 1997). Hamilton (1983) and Gisser and Goodwin (1986) indicate that oil price shocks have an adverse affect on the macroeconomy, and might even be a cause of economic recession. As oil is the lifeline of modern economy and stock markets are closely linked with economic activity, it appears that oil price might have some influence in determining the stock market prices. Increases in oil demand without offsetting increases in supply lead to higher oil prices. The impact of higher oil prices on income, business profits and inflation lowers the value of financial assets (Brychcy, 2006). Oil along-with capital, labour and materials represent important components into the production of most goods and services and changes in the prices of these inputs affects cash flows. Rising oil prices in the absence of any direct alternative lead to higher production costs. Higher production costs dampen cash flows and reduce stock prices (Basher and Sadorsky, 2006). Rising oil prices are also likely to impact the discount rate used in the equity valuation rules. Huang *et al*. (1996) argue that if oil plays an important role in an economy, one would expect changes in oil price to be correlated with changes in stock prices.

There are many studies[3] which have examined the linkage between the oil prices and stock market returns. For example, in a multi country study, Driesprong et al, (2008) find that changes in oil prices do predict stock returns and this predictability is specifically strong in the developed countries. Park and Ratti (2008) show that oil price shocks have a statistically significant negative impact on real stock returns in the U.S. and 12 European oil importing countries. Using a set of 35 global industry indices for the period from April 1983 to September 2005, Nandha and Faff (2008) find that oil prices rises have a detrimental effect

[3] With a view to preserve space, only recent studies are discussed in this section and a more inclusive list of related studies is available in Appendix 1.

on stock returns in all sectors except mining and oil and gas industries. Using evidence from six OECD countries, Miller and Ratti (2009) suggest that over the long-run stock market prices increase as the oil price decreases or decrease as the oil price increases, but after 1999 and until 2008 the expected negative long-run relationship appears to disintegrate. Empirical evidence provided by Nandha and Brook (2009) indicate that oil prices play some role in determining the transport sector returns for the Developed countries, but no such role of oil prices for transport sectors from Asia-pacific, emerging and Latin American countries. Apergis and Miller (2009) conduct a study eight developed countries over the period 1981 to 2007. They find some influence of oil prices on stock markets but argue that international stock market returns do not respond in a large way to oil market shocks. In a company level study, Mohanty and Nandha (2010) find that the oil price risk exposure of US oil and gas companies are generally positive and significant, further they report that oil price risk exposures vary considerably over time, and across firms and industry subsectors. Chen (2010) argues that an increase in the oil prices leads to higher probability of switching from a bull market to a bear market. Gogineni (2010) study 61 US industry groups from 1998 to 2006. He argues that in addition to returns of oil intensive industries, there are some industries which use virtually no oil, but their returns are significantly sensitivity to oil price changes.

Overall, the findings of existing studies are mixed. In relation to China, an exclusively China focused study by Cong et al, (2008) reports that oil price shocks do not show statistically significant impact on the real stock returns in China other than the manufacturing index and some oil companies. These findings appear to be surprising considering that over the recent years (1994 to 2008) the daily total consumption of petroleum products in China has risen by about 148% compared to an increase of about 24% in the daily total consumption of

petroleum products in the whole world. Further, the findings of Cong et al, (2008) appears to be in contradiction with Tang et al (2010) which show that oil price increases have negative effect on output and investment in China. However, Tang et al (2010) argue that the oil price shock impacts the Chinese economy differently from that of free market economies due to pricing controls and distorted pricing mechanisms in China. Conducting a decomposition analysis, they notice a shift in the oil price shock impact after first 6 months.

In summary, the findings of existing studies relating the oil price impact on stock markets are mixed and the evidence on Chinese market is in contradiction with the economic theory. Thus, our study aims to through further light on the 'unique price transmission mechanism in China' indicated by Tang et al (2010). Further, this study is significantly different from existing studies (e.g. Cong et al, 2008) due to its methodological and data aspects (discussed in section 4). Considering the reported shift in the oil price shock impact on Chinese economy after 6 months, we estimate results for both the short and relatively long measures of return as short term returns may be incapable of showing up the underlying relationship between the oil prices and the Chinese stocks.

4. **The data and empirical framework**

3.1 The data

This study is focused on the Chinese stock market and includes 29 sectors for which sufficient data is available. In general, the data series begin from May 1994 and cover the period up to October 2009. However, there are some sectors having a late start. Consequent to different start periods, we have a maximum of 809 and a minimum of 390 weekly data observations. The sector indices and the Chinese market index are representative of the total return where the data has been adjusted for dividends and other returns such as bonus shares

etc. Considering that the oil price, (OPEC Oil Basket Price) is determined in US$/BBL terms, all the stock market indices have been translated into US dollars. The sector names and summary statistics of weekly sector returns and their correlations with the market and the oil returns are available in Table 2[4].

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Insert Table 2

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As a preliminary assessment, it is worth noting that the sector returns are positively correlated with the market and oil returns. In particular, an across the board positive correlation between the oil returns and the sector returns appears to be interesting. Further, this correlation is highest (0.20) for the Mining sector and lowest (0.00) for the Pharma & Bio sector.

3.2 Model description

There are various studies which have explored the impact of oil prices on stock markets and many of them (e.g. Al-Mudhaf and Goodwin, 1993; Faff and Brailsford, 1999; Sadorsky, 1999; Nandha and Faff, 2008; Nandha and Brooks, 2009) have applied a standard market model augmented by the oil price factor. Such models assume that stock market returns are composed of two components, namely an oil price factor and a stock market component. In a symbolic form, this model can be written as:

$$R_t = \alpha + \beta_M R_{M,t} + \beta_O R_{O,t} + \varepsilon_t \qquad (1)$$

where R_t is the t^{th} period stock return, and $R_{M,t}$ and $R_{O,t}$ stand for the market and oil price returns respectively. β_M and β_O indicates market and oil price sensitivities and ε_t is the standard error term.

[4] The data series are sourced from the Datastream and the related return measures are explained in the table notes at the end of Table 2.

In this study, sector and oil returns are measured as the natural logarithm of corresponding price relatives (symbolically, $\log(P_t/P_{t-1})$ representing continuous compounding return over the period t). Considering that we have weekly data set, these shorter sampling intervals may be incapable of showing up the underlying relationship either due to noise or due to the fact that the link is more long-term in nature. This could only be assessed if the study uses the longer intervals. Therefore, the estimates for some longer intervals are also included. Since the periods named monthly (m), quarterly (q), half-yearly (hy) and yearly (y) are more common in use, the corresponding returns are approximated by using 4, 13, 26 and 52 week returns respectively. Thus, the general model for the i-th sector can be expressed as:

$$R_{it} = \alpha_i + \beta_{M,i} R^O_{M,t} + \beta_{O,i} R_{O,t} + \varepsilon_{it} \qquad (2)$$

where R_{it} is the t-period stock return from investment in the i^{th} stock. $R^O_{M,t}$ are the orthogonalised[5] market returns and $R_{O,t}$ stands for the oil price returns. $\beta_{M,i}$ and $\beta_{O,i}$ are indicators of market and oil sensitivities for the i^{th} sector and ε_{it} is the standard error term.

Model 2 is implemented to estimate the results for all the above discussed return periods namely, weekly (w), monthly (m), quarterly (q), half-yearly (hy) and yearly (y). Furthermore, to allow sufficiently large sample sizes, the relatively longer interval measures use overlapping observations. For example, half-yearly returns (approximated by 26 weeks) are generated as $\log(P_{t+26}/P_t)$ by rolling over weekly price pairs (P_{27}, P_1), (P_{28}, P_2), …… (P_n, P_{n-27}) having 26 lags.

[5]Orthogonalised market returns are measured as $R^O_{M,t} = R_{M,t} - (\hat{\alpha} + \hat{\gamma} R_{O,t})$, where $\hat{\alpha}$ and $\hat{\gamma}$ are estimates of α and γ in $R_{M,t} = \alpha + \gamma R_{O,t} + \varepsilon_t$.

The use of overlapping data is common in the published literature, particularly when conducting studies with longer period returns. It is argued that tests with annual returns yield relatively more powerful results; however, as the longer period return data are not available in sufficient numbers, desired tests are made feasible by taking this approach. Fama and French (1988) and Handa *et al.* (1993) are among many others who use overlapping data to generate annual returns used in their studies.[6]

Apart from observing oil sensitivity changes due to the change in the length of return measurement intervals, the study is also interested in whether there is any systematic rejection of the null hypotheses for a particular length of return measurement interval. This action is taken to ensure more confidence in the final conclusions. Thus, Wald tests for short-interval (weekly) oil sensitivity estimates of Chinese stocks against the relatively longer interval estimates are conducted. For a typical sector 'i' and half yearly return measurement interval, the corresponding null hypotheses can be stated as: $\beta_{iw} = \beta_{ihy} = 0$ (v/s $\beta_{iw} = \beta_{ihy} \neq 0$) and $\beta_{iw} = \beta_{ihy}$ (v/s $\beta_{iw} \neq \beta_{ihy}$).

3.3 GMM estimation

A major drawback of applying overlapping approach in generating the long term returns is that this process induces auto correlated errors and heteroskedasticity and, consequently, ordinary least squares inferences might be unreliable. However, GMM (generalised method of moments) approach has some attractive properties and appears to be the most suitable for this study. MacKinlay and Richardson (1991) suggest that GMM based tests are potentially more robust than commonly used tests that rely on unrealistic assumptions about the

[6]However, note that this approach will reduce the total number of observations by 4, 13, 26 and 52 for the monthly, quarterly, half-yearly and yearly returns respectively.

distribution of asset returns. GMM was first introduced by Hansen (1982), and as the name suggests, is a very general estimation method. Most of the commonly used estimation methods (e.g. ordinary least squares, generalised least squares and instrumental variables estimation) can be considered as special cases of GMM. GMM is a robust estimator in that it does not require strong assumptions regarding the distribution of the disturbances. GMM estimation is based upon the assumption that the disturbances in the equations are uncorrelated with a set of instrumental variables. To avoid further complexity (additional to overlapping), the regressor variables are chosen to be instruments for themselves (see MacKinlay & Richardson, 1991). For more on applications of GMM see, for example, Faff and Lau (1997) and Baum *et al.* (2003).

5. Discussion of results

GMM approach is applied to estimate the Model 2 results for all the sectors corresponding to the previously discussed return intervals (w, m, q, hy and y). Considering that oil price is the primary focus, oil sensitivity results for all the return intervals are available in Table 4. However, with a view to present a complete picture of estimates, weekly results for all the parameters, including the values of adjusted R^2, Durbin-Watson (DW) statistics and the number of observations used in particular sector estimates, are presented in Table 3.

As can be seen from Table 3, the adjusted R^2 values are reasonably good and DW statistics values are close to two. These are indicators of a good model fit. Furthermore, all market betas are statistically significant at the 1percent level and estimated values dispersed around

unity. None of the market betas is smaller than 0.75 or larger than 1.25 and all of exhibit positive signs. All this appears to be consistent with the asset pricing models.

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Insert Table 3

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Interestingly (contrary to general expectation) all of the oil-betas are positive though the number of statistically significant oil-betas is very small (three at 1 percent level and two at 5 percent level). Considering that weekly returns usually exhibit a high level of noise, perhaps weekly returns are not a good reflector of oil price sensitivity in the Chinees stocks. Thus, oil price sensitivity results for relatively longer returns are also estimated and presented in an easy to compare format as in Table 4.

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Insert Table 4

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Results in Table 4 reveal two interesting aspects of the Chinese stocks in relation to their oil price sensitivity. First, irrespective of the return measurement interval size (short or long), all the 86 statistically significant oil-betas are positive. This result is in fact very unique and strong in the sense that the relationship between oil prices and stock markets is generally perceived to be negative. This negative perception is often shared by the financial press and also reported in the findings of various empirical studies (Sadorsky, 1999; Papapetrou, 2001; Park and Ratti, 2008). However, some recent studies (Gogineni, 2007; Killian and Park, 2009) show that the response of US stock returns to oil price is dependent on the underlying causes of oil price increase. In particular, the impact on stock returns is positive if the oil shock originates from the aggregate demand. Considering that China has experienced a high level of economic activity over the recent years, this directly translates into high aggregate

demand for energy. Since oil happens to be a significant and unique component of energy, an influence of Chinese demand on oil prices is quite plausible. Consequently, an alignment between the Chinese stocks and oil prices is not surprising. Thus, the results of this study appear to support the relevance of Gogineni (2007) and Killian and Park (2009) arguments in relation to the Chinese stock market.

Second, the number of statistical significant oil-betas is much larger for the relatively longer (q, hy and y) return measures. Particularly, if we apply a half-yearly measure to return calculations, the oil-betas for all the sectors are found to be statistically significant with 25 of them significant at the one percent level. This appears to suggest that a six monthly framework may be optimal so far as the oil sensitivity of Chinese stock market is concerned. On the other side, the weekly and monthly returns do not appear to capture the reality which may be due to high volatility of short term returns. With a view to further validate the relevance of the length of return interval; Wald tests (for mutual equality and equality with zero) are conducted for weekly oil-betas against the monthly, quarterly, half-yearly and yearly oil-beta estimates. These test results are reported in Table 5.

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Insert Table 5

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It is interesting to note that the equality of weekly oil-betas with the longer return oil-betas (half-yearly and yearly) is mostly rejected. On the other side, equality of weekly and monthly oil-betas is rejected only in one case and that too at the 10 percent level. Further, only three of them (weekly and monthly oil-betas) appear to be significantly different from zero. This suggest that oil volatility of the Chinese stocks is better captured by using relatively longer period returns, particularly half yearly returns appear to be an optimal time frame.

6. Summary and conclusions

This study examines the oil price sensitivity of 29 Chinese stock market sectors over the period May 1994 to October 2009. By using weekly sector index series and applying overlapping approach, returns are generated for five different measurement intervals namely, weekly, monthly, quarterly, half-yearly and yearly. As overlapping approach may induce auto correlated errors and heteroskedasticity, it is feared that the ordinary least squares inferences might be unreliable. Therefore, GMM approach is considered to be more suitable for this study (see detail in section 3.3).

Contrary to a general expectation of negative connectivity between the oil prices and stock market returns, the Chinese stock returns appear to have a positive linkage with the oil price. This can be viewed an implication of the increased Chinese demand for energy induced by unprecedented economic growth in China. Further, longer period returns (particularly, half yearly) appear to capture the oil price sensitivity of Chinese stock returns in a better way. Assuming that the past trend continues in future, this would suggest that investing in Chinese stock market could be a good hedge from the negative implications of oil price hikes.

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Figure 1: Oil consumption in China and the Chinese GDP (Correlation: 0.9608)

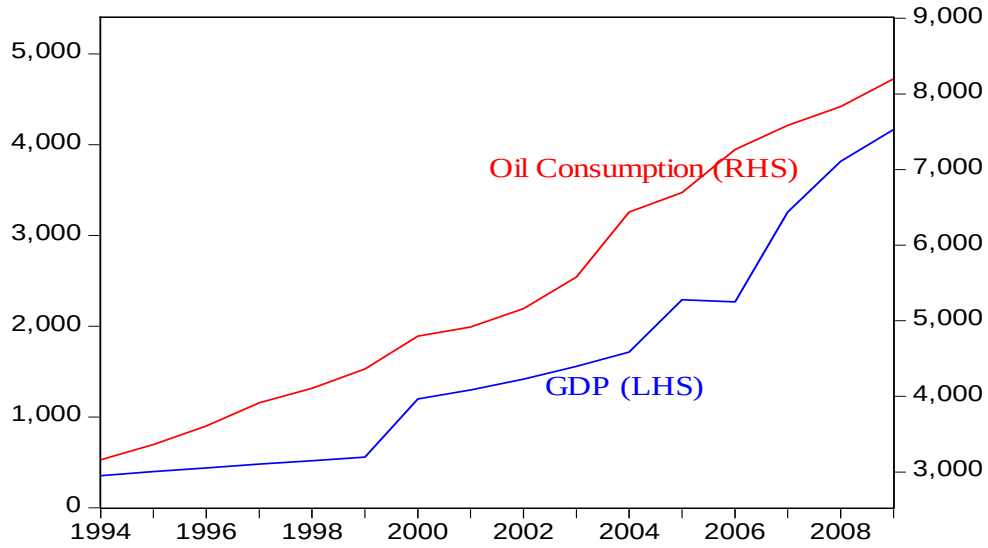

Figure 2: Oil price and the Chinese stock market (Correlation: 0.7271)

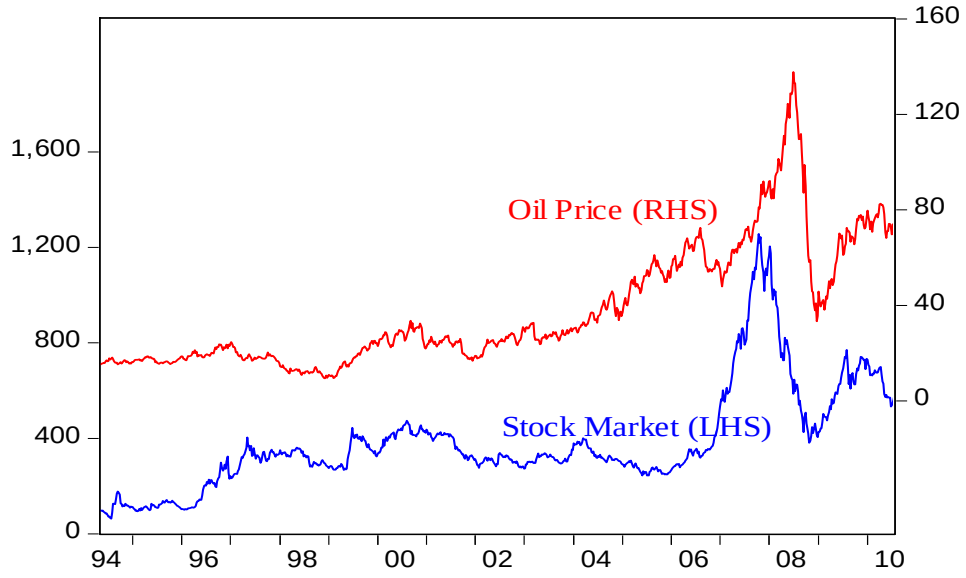

Table 1: Oil consumption, economic activity and stock market statistics for China

Year	*Oil Consumption (Thousand Barrel per day)*	*GDP Value (billion USD)*	*FDI inward (billion USD)*	*FDI outward (billion USD)*	*Number of listed companies*	*Stock market capitalisation (billion USD)*
1994	3160	353.0	33.8	2.0	291	5.6
1995	3363	397.6	37.5	2.0	323	19.1
1996	3610	438.4	41.7	2.1	530	77.8
1997	3916	480.2	45.3	2.6	745	137.1
1998	4105	517.9	45.5	2.6	851	147.0
1999	4363	557.3	40.3	1.8	949	202.4
2000	4795	1,198.6	40.7	0.9	1,088	362.8
2001	4917	1,298.2	46.9	6.9	1,160	293.8
2002	5161	1,416.0	52.7	2.5	1,224	254.3
2003	5578	1,558.1	53.5	2.9	1,287	261.3
2004	6437	1,715.3	60.6	5.5	1,377	232.8
2005	6695	2,291.6	72.4	12.3	1,381	181.1
2006	7263	2,268.3	72.7	21.2	1,434	444.4
2007	7582	3,257.0	83.5	22.5	1,550	1574.3
2008	7831	3,816.7	108.3	52.2	1,625	810.9
2009	8200	4,167.4	95.0	48.0	NA	NA

Sources:
CIA world book at: https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html
China Securities Regulatory Commission at:
http://www.csrc.gov.cn/pub/csrc_en/about/annual/200907/P020090701496625000834.pdf

Table 2: Summary statistics of weekly sector returns and their correlations with the market return and oil price growth.

Sector	Mean	Median	Max	Min	Std. Dev.	Skew-ness	Kurt-osis	*Correlations*	
								Market	Oil
Aero/Defence	0.0025	0.0000	0.2444	-0.2776	0.0632	-0.0902	5.66	0.55	0.03
Auto & Parts	0.0017	-0.0009	0.4225	-0.2353	0.0586	1.0296	10.13	0.81	0.01
Banks	0.0035	-0.0002	0.3055	-0.2821	0.0533	1.0628	10.23	0.81	0.05
Beverages	0.0038	0.0012	0.1613	-0.1474	0.0420	0.3918	4.67	0.67	0.04
Chemicals	0.0025	-0.0019	0.4990	-0.2664	0.0554	1.4535	16.86	0.84	0.08
Con & Mat	0.0024	0.0000	0.2862	-0.2162	0.0498	0.6790	7.62	0.82	0.03
Eltro/Elec Eq	0.0028	0.0000	0.3128	-0.2809	0.0558	0.7382	7.89	0.78	0.04
Electricity	0.0029	0.0004	0.3799	-0.3005	0.0521	0.7543	10.81	0.81	0.03
Fd Producers	0.0026	0.0002	0.4353	-0.3614	0.0576	0.0281	11.78	0.75	0.06
Forestry & Pap	0.0030	0.0001	0.4600	-0.2609	0.0561	1.0030	11.83	0.79	0.03
Gen Retailers	0.0029	0.0010	0.3148	-0.2264	0.0519	0.8442	7.94	0.77	0.05
General Inds	0.0015	-0.0001	0.3379	-0.2187	0.0535	0.3110	6.36	0.79	0.04
Gs/Wt/Mul Util	0.0030	0.0001	0.4404	-0.3332	0.0659	0.8252	10.35	0.76	0.04
H/H Gds, Home Con	0.0021	0.0004	0.5308	-0.2584	0.0561	1.5991	18.45	0.74	0.02
Inds Transpt	0.0021	-0.0015	0.3659	-0.2845	0.0545	1.2222	11.57	0.88	0.07
Ind. Met & Mines	0.0024	0.0004	0.5308	-0.2585	0.0567	1.4716	18.06	0.88	0.09
Leisure Gds	0.0003	-0.0002	0.4375	-0.2797	0.0562	0.4783	9.57	0.72	0.03
Media	0.0018	-0.0002	0.3619	-0.2677	0.0611	0.2756	7.70	0.69	0.04
Mining	0.0034	0.0002	0.2398	-0.1777	0.0521	0.2977	4.82	0.81	0.20
Mobile T/Cm	0.0012	-0.0004	0.3220	-0.2610	0.0634	0.4391	6.16	0.58	0.11
Oil & Gas Prod	0.0021	-0.0003	0.2749	-0.2029	0.0481	0.4326	6.67	0.76	0.11
Oil/Eq Svs/Dst	0.0019	0.0004	0.1904	-0.2223	0.0482	-0.0039	4.76	0.73	0.16
Personal Goods	0.0043	0.0014	0.2396	-0.2128	0.0561	-0.0041	4.76	0.72	0.04
Pharm & Bio	0.0025	0.0017	0.6044	-0.3080	0.0548	1.8077	24.43	0.70	0.00
Real Estate	0.0022	-0.0003	0.3350	-0.2467	0.0574	0.5973	7.02	0.81	0.03
S/W & Comp Svs	0.0043	0.0031	0.3443	-0.3227	0.0531	0.3034	7.96	0.73	0.03
Support Svs	0.0036	0.0009	0.5245	-0.3617	0.0614	0.7330	12.43	0.78	0.09
Tch H/W & Eq	0.0018	0.0001	0.1755	-0.2038	0.0487	0.0664	4.76	0.77	0.06
Travel & Leis	0.0021	0.0004	0.5004	-0.2878	0.0572	1.3680	16.01	0.80	0.02
Market	0.0027	0.0009	0.3483	-0.2560	0.0466	0.9044	12.28	1.00	0.10

Notes: explain return measures, market = Chinese market, oil return = oil price return

Table 3: GMM estimates of the Chinese stock market sectors using weekly data

Sector	α	β_M	β_O	adjR2	DW	Nobs
Aero/Defence	0.0036	0.9439	0.0207	0.3059	2.0650	462
	(1.49)	(9.93)	(0.50)			
Auto & Parts	0.0016	1.0212	0.0087	0.6583	1.9612	804
	(1.19)	(24.53)	(0.35)			
Banks	0.0035	0.8614	0.0083	0.5664	1.8486	808
	(2.51)	(12.57)	(0.27)			
Beverages	0.0047	0.7852	0.0096	0.4582	2.1068	641
	(4.00)	(19.41)	(0.39)			
Chemicals	0.0025	1.0410	0.0377	0.7658	1.8419	808
	(2.38)	(22.49)	(1.82)			
Con & Mat	0.0024	0.9218	0.0217	0.7415	1.9986	808
	(2.56)	(28.13)	(0.89)			
Eltro/Elec Eq	0.0027	1.0065	0.0211	0.7066	2.0348	806
	(2.45)	(25.72)	(0.79)			
Electricity	0.0029	0.9783	-0.0069	0.7627	2.1160	808
	(3.32)	(28.80)	(-0.25)			
Fd Producers	0.0026	0.8331	0.0171	0.3580	1.6432	782
	(1.25)	(16.53)	(0.46)			
Forestry & Pap	0.0030	1.0058	0.0340	0.6984	2.0316	808
	(2.64)	(25.27)	(1.53)			
Gen Retailers	0.0029	0.9011	0.0105	0.6541	2.0299	808
	(2.60)	(29.67)	(0.46)			
General Inds	0.0027	1.0864	0.0029	0.6134	2.1297	673
	(2.05)	(23.35)	(0.13)			
Gs/Wt/Mul Util	0.0030	1.1209	-0.0015	0.6263	2.0811	808
	(2.20)	(28.46)	(-0.05)			
H/H Gds, Home Con	0.0020	0.9665	0.0282	0.6428	1.8722	808
	(1.67)	(15.30)	(1.14)			
Inds Transpt	0.0021	0.9563	0.0361	0.6681	2.1110	808
	(1.82)	(21.55)	(1.73)			
Ind. Met & Mines	0.0019	1.0304	0.0553	0.7184	1.9623	800
	(1.76)	(17.74)	(2.34)			
Leisure Gds	0.0005	1.0034	0.0138	0.5922	2.0029	793
	(0.40)	(20.34)	(0.60)			
Media	0.0029	1.0781	0.0333	0.4711	1.9926	676
	(1.72)	(16.51)	(1.04)			
Mining	0.0040	1.0848	0.1190	0.6011	2.1629	575
	(3.04)	(19.21)	(3.66)			
Mobile T/Cm	0.0010	0.9062	0.0547	0.4428	2.0635	808
	(0.66)	(21.45)	(1.72)			
Oil & Gas Prod	0.0032	0.9844	0.0537	0.5641	2.1936	598
	(2.71)	(21.48)	(2.60)			
Oil/Eq Svs/Dst	0.0023	0.9145	0.1154	0.5057	2.0686	569
	(1.66)	(16.89)	(4.09)			
Personal Goods	0.0044	1.0336	-0.0024	0.5117	1.9583	389

	(2.05)	(17.67)	(-0.07)			
Pharm & Bio	0.0024	0.8746	0.0166	0.5523	2.0585	808
	(1.89)	(18.95)	(0.59)			
Real Estate	0.0022	1.0171	0.0283	0.6801	2.0465	808
	(2.00)	(24.29)	(0.97)			
S/W & Comp Svs	0.0047	0.8621	0.0515	0.4220	1.9566	697
	(2.80)	(11.13)	(1.75)			
Support Svs	0.0035	0.9894	0.0640	0.5637	2.0278	808
	(2.49)	(16.65)	(2.26)			
Tch H/W & Eq	0.0029	0.9868	0.0258	0.5539	2.0831	593
	(2.08)	(18.46)	(0.96)			
Travel & Leis	0.0021	1.0009	-0.0115	0.6626	1.9688	808
	(1.64)	(18.02)	(-0.48)			

Notes:

a. This table presents complete results for the model: $R_{it} = \alpha_i + \beta_{M,i} R^{O}_{M,t} + \beta_{O,i} R_{O,t} + \varepsilon_{it}$ based on weekly returns. The other terms used in this model are described under model (1) in the text.

b. The values in the parentheses are t-stats whereas adjR^2 stands for adjusted R^2, DW= Durbin-Watson stat and Nobs = the number of observations used in particular sector estimates.

Table 4: Short and long-run oil sensitivity estimates of the Chinese stock market sectors

Sector	Short-run		Long-run		
	$\beta_o(w)$	$\beta_o(m)$	$\beta_o(q)$	$\beta_o(hy)$	$\beta_o(y)$
Aero/Defence	0.0207	-0.0370	0.1077	0.1463	0.0539
	(0.50)	(-0.66)	(1.52)	(2.03)	(0.55)
Auto & Parts	0.0087	-0.0191	0.1289	0.1806	0.0960
	(0.35)	(-0.65)	(2.99)	(3.16)	(1.51)
Banks	0.0083	0.0079	0.1020	0.2310	0.3072
	(0.27)	(0.21)	(2.52)	(5.62)	(5.49)
Beverages	0.0096	0.0270	0.1270	0.2033	0.2791
	(0.39)	(0.72)	(2.56)	(5.11)	(6.29)
Chemicals	0.0377	0.0303	0.1904	0.2659	0.3280
	(1.82)	(1.12)	(4.32)	(6.35)	(7.59)
Con & Mat	0.0217	-0.0036	0.0435	0.1290	0.2511
	(0.89)	(-0.10)	(1.00)	(3.31)	(7.00)
Eltro/Elec Eq	0.0211	-0.0248	0.0057	0.0986	0.1383
	(0.79)	(-0.63)	(0.11)	(1.96)	(2.00)
Electricity	-0.0069	-0.0306	0.0509	0.1198	0.2123
	(-0.25)	(-1.11)	(1.36)	(3.47)	(6.26)
Fd Producers	0.0171	-0.0018	0.2099	0.3115	0.4479
	(0.46)	(-0.03)	(2.24)	(3.68)	(3.25)
Forestry & Pap	0.0340	0.0327	0.2000	0.2947	0.3921
	(1.53)	(0.72)	(2.71)	(4.01)	(6.22)
Gen Retailers	0.0105	0.0139	0.1515	0.2338	0.2507
	(0.46)	(0.42)	(3.65)	(7.77)	(6.89)
General Inds	0.0029	-0.0104	0.0811	0.1369	0.1244
	(0.13)	(-0.27)	(1.56)	(2.79)	(2.28)
Gs/Wt/Mul Util	-0.0015	-0.0143	0.0519	0.1109	0.1098
	(-0.05)	(-0.32)	(0.92)	(2.26)	(2.37)
H/H Gds, Home Con	0.0282	-0.0216	0.1044	0.2239	0.3432
	(1.14)	(-0.71)	(2.28)	(4.60)	(6.55)
Inds Transpt	0.0361	-0.0057	0.1088	0.1897	0.2890
	(1.73)	(-0.14)	(1.90)	(3.59)	(5.95)
Ind. Met & Mines	0.0553	0.0349	0.1962	0.2914	0.3925
	(2.34)	(1.11)	(5.33)	(6.70)	(7.99)
Leisure Gds	0.0138	-0.0237	0.0999	0.1505	0.1499
	(0.60)	(-0.75)	(2.10)	(3.80)	(4.77)
Media	0.0333	-0.0016	0.0561	0.1596	0.2771
	(1.04)	(-0.04)	(1.07)	(3.24)	(3.84)
Mining	0.1190	0.0990	0.3308	0.4656	0.5119

	(3.66)	(2.50)	(8.51)	(10.69)	(10.58)
Mobile T/Cm	0.0547	-0.0163	0.0200	0.1552	0.3225
	(1.72)	(-0.32)	(0.40)	(4.15)	(4.82)
Oil & Gas Prod	0.0537	0.0520	0.1625	0.2151	0.3225
	(2.60)	(2.03)	(5.22)	(6.30)	(7.80)
Oil/Eq Svs/Dst	0.1154	0.1034	0.1734	0.2560	0.3580
	(4.09)	(2.34)	(2.57)	(5.87)	(7.04)
Personal Goods	-0.0024	-0.0398	0.1436	0.2651	0.5005
	(-0.07)	(-0.77)	(2.83)	(6.14)	(6.73)
Pharm & Bio	0.0166	0.0170	0.0664	0.1348	0.1905
	(0.59)	(0.43)	(1.51)	(3.28)	(3.46)
Real Estate	0.0283	0.0436	0.1184	0.2358	0.3411
	(0.97)	(1.01)	(2.30)	(4.69)	(6.05)
S/W & Comp Svs	0.0515	0.0566	0.0826	0.1389	0.1463
	(1.75)	(1.30)	(1.39)	(1.95)	(1.58)
Support Svs	0.0640	0.0729	0.2511	0.3602	0.4659
	(2.26)	(1.55)	(5.65)	(7.54)	(9.46)
Tch H/W & Eq	0.0258	0.0349	0.1920	0.2993	0.4226
	(0.96)	(0.67)	(2.91)	(6.73)	(9.18)
Travel & Leis	-0.0115	-0.0270	0.1030	0.1933	0.3319
	(-0.48)	(-0.77)	(2.62)	(4.61)	(4.98)
Total market*	0.0379	0.0222	0.1405	0.2267	0.2989
	(0.94)	(0.38)	(1.96)	(2.91)	(3.09)

Notes:

a. This table presents the oil sensitivity (oil beta, $\beta_{O,i}$) estimates for Chinese stock market sectors (with t-stats in the parentheses) by implementing the model: $R_{it} = \alpha_i + \beta_{M,i} R^{O}_{M,t} + \beta_{O,i} R_{O,t} + \varepsilon_{it}$. Further, β_o(w), β_o(m), β_o(q), β_o(hy) and β_o(y) indicate the estimates of oil beta for weekly, monthly, quarterly, half-yearly and yearly returns respectively. The terms used in this model are described under models (1) and (2) in the text.

b. All the estimates for the market Beta $\beta_{M,i}$ are significant at one percent level, but are not presented in the table with a view to preserve space.

c. Total market estimates are based on the model $R_{Mt} = \alpha + \beta R_{O,t} + \varepsilon_t$

Table 5: Wald tests for the short-run oil sensitivity against the long-run oil sensitivity

	Short-run		Long-run					
sec ID	β(w)=β(m)=0	β(w)=β(m)	β(w)=β(q)=0	β(w)=β(q)	β(w)=β(hy)=0	β(w)=β(hy)	β(w)=β(y)=0	β(w)=β(y)
Aero/Defence	0.9378	0.9289	2.5611	1.1114	5.0837	1.9133	0.5634	0.0979
p-values	(0.6257)	(0.3352)	(0.2779)	(0.2918)	(0.0787)	(0.1666)	(0.7545)	(0.7543)
Auto & Parts	0.8508	0.8460	9.2043	5.5772	11.5824	6.2727	2.3088	1.8191
	(0.6535)	(0.3577)	(0.0100)	(0.0182)	(0.0031)	(0.0123)	(0.3152)	(0.1774)
Banks	0.0786	0.0002	6.5545	3.2506	32.3821	17.2877	30.4203	21.2110
	(0.9615)	(0.9901)	(0.0377)	(0.0714)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Beverages	0.5249	0.2747	6.6049	5.6123	23.2677	17.0041	34.8423	25.0861
	(0.7692)	(0.6002)	(0.0368)	(0.0178)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Chemicals	3.7280	0.0631	22.5721	9.5694	43.4768	24.0021	58.7976	39.7624
	(0.1551)	(0.8016)	(0.0000)	(0.0020)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Con & Mat	1.5473	0.8561	1.3606	0.2642	11.3513	5.9029	49.0411	32.8820
	(0.4613)	(0.3548)	(0.5065)	(0.6072)	(0.0034)	(0.0151)	(0.0000)	(0.0000)
Eltro/Elec Eq	2.4187	2.0116	0.6258	0.0853	4.1339	2.0827	4.1513	2.8585
	(0.2984)	(0.1561)	(0.7313)	(0.7703)	(0.1266)	(0.1490)	(0.1255)	(0.0909)
Electricity	1.2980	0.6601	1.8834	1.4757	12.0954	7.2918	39.4761	26.2745
	(0.5226)	(0.4165)	(0.3900)	(0.2244)	(0.0024)	(0.0069)	(0.0000)	(0.0000)
Fd Producers	0.2817	0.1399	5.5099	3.4003	13.8105	10.1041	10.6088	9.6440
	(0.8686)	(0.7084)	(0.0636)	(0.0652)	(0.0010)	(0.0015)	(0.0050)	(0.0019)
Forestry & Pap	2.4506	0.0008	11.7748	4.1914	21.8790	10.3347	43.5553	26.8988
	(0.2937)	(0.9775)	(0.0028)	(0.0406)	(0.0000)	(0.0013)	(0.0000)	(0.0000)
Gen Retailers	0.2548	0.0140	13.3676	10.6118	61.6187	32.1297	47.7356	31.1912
	(0.8804)	(0.9059)	(0.0013)	(0.0011)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
General Inds	0.1672	0.1610	2.4294	1.9604	7.9270	5.7643	5.2132	4.5047
	(0.9198)	(0.6882)	(0.2968)	(0.1615)	(0.0190)	(0.0164)	(0.0738)	(0.0338)
Gs/Wt/Mul Util	0.1149	0.0960	0.8537	0.6055	5.3639	4.5367	5.6925	4.3578
	(0.9442)	(0.7566)	(0.6525)	(0.4365)	(0.0684)	(0.0332)	(0.0581)	(0.0368)
H/H Gds, Home Con	3.4482	3.1298	5.4455	2.8476	21.2082	15.5997	42.9951	32.4410
	(0.1783)	(0.0769)	(0.0657)	(0.0915)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Inds Transpt	3.8495	1.3303	5.3179	1.6925	13.5151	8.9614	37.3923	23.7996
	(0.1459)	(0.2488)	(0.0700)	(0.1933)	(0.0012)	(0.0028)	(0.0000)	(0.0000)
Ind. Met & Mines	5.5231	0.4406	36.4044	9.6157	55.0102	20.6523	70.9117	37.1145
	(0.0632)	(0.5068)	(0.0000)	(0.0019)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Leisure Gds	1.5039	1.4665	5.1139	2.4400	15.7461	7.9643	23.8602	11.2198
	(0.4714)	(0.2259)	(0.0775)	(0.1183)	(0.0004)	(0.0048)	(0.0000)	(0.0008)
Media	1.4933	0.8790	2.1721	0.1400	12.5020	4.1727	16.4497	9.1171
	(0.4740)	(0.3485)	(0.3375)	(0.7083)	(0.0019)	(0.0411)	(0.0003)	(0.0025)
Mining	13.6285	0.3452	72.9710	34.5092	118.5604	47.6165	112.3101	62.8123
	(0.0011)	(0.5569)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Mobile T/Cm	4.3344	2.3221	3.1157	0.3360	19.1522	4.5379	24.7245	14.2469
	(0.1145)	(0.1276)	(0.2106)	(0.5622)	(0.0001)	(0.0332)	(0.0000)	(0.0002)

Oil & Gas Prod	8.1066	0.0041	32.3905	8.9755	43.8620	17.6969	62.3388	39.4795
	(0.0174)	(0.9491)	(0.0000)	(0.0027)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Oil/Eq Svs/Dst	16.7422	0.0998	19.9988	0.7271	46.5130	8.1187	66.5268	17.3468
	(0.0002)	(0.7521)	(0.0000)	(0.3938)	(0.0000)	(0.0044)	(0.0000)	(0.0000)
Personal Goods	0.6720	0.5955	8.1109	6.1733	37.6622	22.9537	45.7339	40.1446
	(0.7146)	(0.4403)	(0.0173)	(0.0130)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Pharm & Bio	0.3765	0.0001	2.4654	1.0313	10.7938	7.1335	11.9749	9.4580
	(0.8284)	(0.9917)	(0.2915)	(0.3098)	(0.0045)	(0.0076)	(0.0025)	(0.0021)
Real Estate	1.3211	0.1594	6.7122	2.1491	26.9333	10.5076	38.3327	23.1632
	(0.5166)	(0.6897)	(0.0349)	(0.1426)	(0.0000)	(0.0012)	(0.0000)	(0.0000)
S/W & Comp Svs	3.1712	0.0209	4.6612	0.2354	7.1470	1.2494	4.7074	1.0650
	(0.2048)	(0.8850)	(0.0972)	(0.6276)	(0.0281)	(0.2637)	(0.0950)	(0.3021)
Support Svs	5.3215	0.0469	37.5558	12.3390	64.6745	26.7632	89.9087	58.9631
	(0.0699)	(0.8285)	(0.0000)	(0.0004)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tch H/W & Eq	0.9852	0.0385	9.1355	5.6063	45.3674	30.5052	84.3874	62.6943
	(0.6110)	(0.8445)	(0.0104)	(0.0179)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Travel & Leis	0.6486	0.2038	6.9876	5.9681	21.3912	17.5480	24.9711	23.2088
	(0.7230)	(0.6517)	(0.0304)	(0.0146)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

a. This table presents Wald tests for the weekly oil sensitivity against the relatively longer interval oil sensitivity estimates. For a typical longer interval (say quarterly), the corresponding hypotheses can be stated as: $\beta(w)=\beta(q)=0$ [v/s $\beta(w)=\beta(q \neq 0]$ and $\beta(w)=\beta(q)$ [v/s $\beta(w)\neq \beta(q)$].

b. The figures in the parentheses are p-values.

Appendix 1: A summary of major oil priced focused studies

Author/s	Pub Year	Data description	Major findings
Huang, Masulis and Stoll	1996	S&P 500 and NYMEX, April 1983 to march 1990	Oil futures returns are not correlated with stock returns, even contemporaneously, except in the case of oil company returns.
Jones and Kaul	1996	Quarterly observations of US and Japan were used from 1970-1991. Canadian and U.K. samples include mainly post-1960 period.	In case of US and Canadian markets the reaction of stock prices to oil shocks can be completely accounted for by their impact on current and expected future real cash flows alone, this is not the case with UK and Japanese markets.
Sadorsky	1999	Real oil prices, Industrial production and interest rates were taken up from January 1947 to April 1996.	Oil prices and oil price volatility both play important roles in affecting real stock returns. Oil price volatility shocks have asymmetric effects on the economy.
Papapetrou	2001	Monthly observations of real oil price, industrial production, interest rate, employment and real stock return from January 1989 to June 1999.	Oil price changes affect real economic activity and employment in Greece but stock returns do not lead to changes in real activity and employment.
El-Sharif, Brown,Burton, Nixon, and Russell.	2005	Daily data from January 1989 to June 2001.	Relationship between crude oil price and equity values of oil and gas sector is positive and often highly significant in U.K. market.
Hammoudeh and Choi	2006	Weekly observations of two oil price series, US T-bill rate and S&P 500 index were examined from 1994 to 2004.	S&P500 index and the oil price have no direct impact on Gulf Cooperation Council's weekly equity returns. Moreover, a positive oil shock will benefit most of these markets.
Basher and Sadorsky	2006	21 emerging stock markets from December 1992 to October 2005,	Oil price impact stock price returns in emerging markets.
Gogineni	2007	Daily observations of NYSE/NASDAQ/AMEX, NYMEX oil price, interest rate and industry returns from 1983 to 2006.	In addition to oil intensive industries, industries that do not use oil to any significant extent are also sensitive to oil price changes.
Nandha and Faff	2008	35 global industry indices for the period from April 1983 to September 2005	Equity returns for all sectors except mining, and oil and gas industries show negative sensitivity to oil price rises.
Park and Ratti	2008	The monthly stock prices, interest rates, consumer prices, and industrial production for the U.S. and 13 European countries from 1986 to 2005.	Oil price shocks have a statistically significant impact on real stock returns in the same month or within one month in the US and 13 European countries.
Driesprong et al.,	2008	Monthly series of value-weighted market indices of eighteen countries and several measures of oil price has taken up from 1973 to 2003.	Report strong evidence showing that changes in oil prices forecast stock returns. This predictability is especially strong in the developed markets.
Cong et al.,	2008	Monthly Oil price, interest rates, CPI, industrial production, Shanghai and Shenzhen stock market composite indices, 10 classification indices and four oil companies stock prices from 1996 to 2007.	Oil price shocks do not show statistically significant impact on the real stock returns of most Chinese stock market indices, except for manufacturing index and some oil companies.

Nandha and Brooks	2009	Transport sectors of 38 countries for from April 1983 to July 2006.	Oil prices appear to play some role in determining the transport sector returns in mature economies. Particularly, the oil factor has been found to be jointly significant along with the presence of negative oil risk premium in the G7 countries.
Miller and Ratti	2009	Monthly series from January 1971 to March 2008 of world real crude oil price and real stock price of six OECD countries.	Find long run relationship between real stock prices and world real oil price from January 1971 to May 1980 and then from February 1988 to September 1999. Further they report that in post 1999 the relationship between real oil price and stock return has changed.
Apergis and Miller	2009	Oil price, level of crude oil production, consumer price index, real economic activity (proxy by freight rates) and stock market price of eight developed countries in monthly series from 1981 to 2007 has been taken.	The results show that different oil-market structural shocks (oil supply shocks, global aggregate-demand shocks, and idiosyncratic demand shocks) play a significant role in explaining the adjustments in stock-market returns.
Mohanty and Nandha	2010	Sample includes 40 US oil and gas companies over the period July 1992- December 2008.	This study indicates that the oil price risk exposures of U.S. oil and gas companies in the oil and gas sector are generally positive and significant. Further, oil price risk exposures vary considerably over time, and across firms and industry subsectors.
Chen	2010	Monthly observations of S&P 500 stock price index and the world average crude oil price index from January 1957 to May 2009.	An increase in oil prices leads to a higher probability of a bear market emerging.