Facultad de Ciencias Económicas y Empresariales
Universidad de Navarra

Working Paper nº 06/04

Oil Prices, Economic Activity and Inflation: Evidence for Some Asian Countries

Juncal Cunado and Fernando Perez de Gracia

Facultad de Ciencias Económicas y Empresariales
Universidad de Navarra

OIL PRICES, ECONOMIC ACTIVITY AND INFLATION: EVIDENCE FOR SOME ASIAN COUNTRIES

Juncal Cunado and Fernando Perez de Gracia

Working Paper No.06/04
April 2004
JEL No. E32, Q43, O53

ABSTRACT

In this paper we study the oil prices-macroeconomy relationship by means of studying the impact of oil price shocks on both economic activity and consumer price indexes for six Asian countries over the period 1975Q1-2002Q2. The results suggest that oil prices have a significant effect on both economic activity and price indexes although the impact is limited to the short-run and more significant when oil price shocks are defined in local currencies. Moreover, we find evidence of asymmetries in the oil prices-macroeconomy relationship for some of the Asian countries.

J. Cunado
Universidad de Navarra
Depto. de Métodos Cuantitativos
Campus Universitario
31080 Pamplona
jcunado@unav.es

F. Perez de Gracia
Universidad de Navarra
Depto. de Economía
Campus Universitario
31080 Pamplona
fgracia@unav.es

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the useful comments and suggestions from two anonymous referees. Financial support from the Ministerio de Ciencia y Tecnología (SEC2002-01839, Spain) and Plan de Investigación de la Universidad de Navarra (PIUNA; 2001-09) is also acknowledged. The usual disclaimer applies.

1. Introduction

Among the most severe supply shocks hitting the world economies since World War II were sharp increases in the price of oil and other energy products. Oil price shocks receive important consideration for their presumed role on macroeconomic variables.[1] They are included in several models such as those of Rasche and Tatom (1981), Bruno and Sachs (1982) and Hamilton (1988). Furthermore, they have been credited with affecting the natural rate of unemployment (e.g., Caruth et al., 1998; Davis and Haltiwanger, 2001; Phelps, 1994), reducing the role of technology shocks in real business cycle models (Davis, 1986) and depressing irreversible investment through their effects on uncertainty (Ferderer, 1996). Thus, from a theoretical point of view, there are different reasons why an oil shock should affect macroeconomic variables, some of them calling for a non-linear specification of the oil price-macroeconomy relationship. For example, the oil shock can lead to lower aggregate demand since the price rise redistributes income between the net oil countries which are net oil importers and exporters. Second, the oil price increase reduces aggregate supply since higher energy prices mean that firms purchase less energy; consequently, the productivity of any given amount of capital and labor declines and potential output falls. The decline in factor productivity implies that real wages will be lower. If some labor supply is withdrawn voluntarily as a result, potential output will be lower than it would otherwise be, thus compounding the direct impact of lower productivity. Furthermore, it may have a non-linear effect on economic activity if it affects through sectoral reallocations of resources

[1] Recently, Brown and Yücel (2002) survey the theory and evidence between economic activity and oil prices.

or depressing irreversible investment through their effects on uncertainty (Ferderer, 1996).[2]

From an empirical point of view, considerable research finds that oil price shocks have affected output and inflation (e.g., Hamilton, 1983, 1988, 1996, 2000; Hooker, 1996, 1999, 2002; Huntington, 1998; Kahn and Hamptom, 1990; Tatom, 1988; Mork, 1989, 1994). Research also supports the view that these shocks have been an important source of economic fluctuation over the past three decades (Kim and Loungani, 1992).

However, there are various questions, which are still far from a consensus. First, empirical evidence shows that oil prices fail to Granger cause macroeconomic variables when data samples are extended past the mid-80s, due to the nominal price decreases beginning in 1981 and wide swings, following the market collapse in 1985. Several authors argue that this breakdown of the oil prices-macroeconomy relationship reveals that the relation between these variables is nonlinear and propose different nonlinear specifications of this relation (e.g., Lee et al., 1995 and Hamilton, 1996).[3]

Second, and in an international context, an oil shock may have a differential impact on each of the countries due to some variables such as their sectoral composition, their relative position as oil importer or exporter or their differential tax structure.

[2] See Mork (1994) for a further discussion of various transmission mechanisms.

[3] One of the proposed specifications is an asymmetric relationship where oil price increases have a significant effect on macroeconomic variables while this does not occur for oil price decreases (Mork, 1989). However, other authors (Lee et al., 1995; Hamilton, 1996) argue that the asymmetric relationship proposed by Mork (1989) offers a relatively poor fit to data after 1986 and propose alternative asymmetric and nonlinear relationships.

The main goal of this paper is to analyze the oil price-macroeconomy relationship by means of applying cointegration and Granger causality tests on the oil price-inflation rate and oil price-production growth rate relationships for six Asian countries using quarterly data for the period 1975Q1-2002Q2. In order to account for the possible asymmetry and other type of nonlinearities between oil prices and macroeconomic variables, we shall use different transformations of oil price data, each of one suggesting a different channel through which oil prices may affect industrial production levels.

There are several reasons that justify the interest in the energy price and macroeconomic relationship in Asian countries. First, it is becoming more important to understand the macroeconomic behavior in Asian countries, as recognized by the 1997 crises and its impact on other economies. Second, most of the papers on the effect of oil prices are applied to the US case or OECD countries and only a few papers study the Japanese case (Lee et al., 2001; Hutchison 1993; Takenaka, 1991) and other Asian economies (Abeysinghe, 2001). Third, in our sample we include both a net oil exporter (Malaysia) and net oil importers (Japan, Singapore, South Korea, Philippines and Thailand), which could help us to examine whether the oil price – macroeconomy relationship in emerging Asian economies depends on the different net import or export behavior of each country.[4]

[4] Although there are a few studies (see for example Mork et al., 1994 and Abeysinghe, 2001) in which a slightly different relationship between oil prices and macroeconomic variables is found for oil importer and oil exporter countries, this is not a conclusive result. In this paper, we also find that the relationship between oil prices, economic activity and consumer prices seems to be less significant for Malaysia than for the rest of the countries. However, it is difficult to reach general conclusions from this sole result and although the results seems to suggest that the response of the oil-exporting countries may differ from that of oil-importing countries, further research is needed to obtain a more reliable conclusion.

The plan of the paper is as follows. In Section 2 we briefly present the main features on oil price market in order to justify the proxy variables of oil price shocks we use in the empirical analysis. Section 3 covers the empirical analysis and Section 4 provides some concluding remarks.

2. A first look at oil price data

The choice of oil price variables is difficult and, as we shall show later, important. National oil prices have been influenced by price-controls, high and varying taxes on petroleum products, exchange rate fluctuations (such as the important devaluations after the Asian crisis in most of the countries in our sample) and national price index variations. All the differential characteristics which influence the effective oil price that each of the countries face raise great difficulties in measuring the appropriate oil price variable for each country. Thus, most of the empirical literature which analyze the effect of oil price shocks in different economies[5] use either the $US world price of oil as a common indicator of the world market disturbances that affect all countries (see for example, Burbidge and Harrison, 1984) or this world oil price converted into each respective country's currency by means of the market exchange rate (see for example Mork et al. (1994) for OECD countries or Abeysinghe (2001) for Asian countries). The main difference between the two variables is that only the second one takes into account the differences in the oil price that each of the countries faces due to its exchange rate fluctuations or its inflation levels. In this paper we use these two variables in order to differentiate whether each oil price shock reflects the world oil price evolution or could

[5] Most of the papers which analyze this issue for the US case use the world price of crude oil (Hamilton, 1996) or in real terms by means of dividing this variable by a price index for all commodities (Hooker, 1999).

be due to other factors such as exchange rate fluctuations or national price index variations.

The world oil price was deflated using the price of all commodities and the domestic (local) oil prices were deflated using the inflation indicator of each country. All the variables except proxies for economic activity in Malaysia, Thailand and Philippines have been obtained from the International Financial Statistics (International Monetary Fund).[6]

Figure 1 shows for each of the Asian countries, the evolution of both the real oil price expressed in $US and in the local currency over the period 1975Q1-2002Q2. In all the series we observe the effects of the three main negative oil shocks (1978-1979, 1990, 1999-2000) and the fall in oil prices after the market collapsed in mid-eighties. However, it is worth mentioning the different evolution of oil prices when they are expressed in $US or in each of the countries' currencies. As observed in the figure, one of the main differences between these two variables is due to the persistence of the dollar price in the first half of the 1980s due to the behavior of the exchange rates of the Asian currencies against the $US. Thus, while real oil prices in domestic currencies present a downward trend since 1980, the real oil price expressed in $US exhibit some increases in 1982-83, 1990 and 1999.

[Insert Figure 1]

[Insert Table 1]

Table 1 presents the correlation coefficients among local oil prices and oil prices in $US. The table shows a high degree of correlation both among the local oil prices for all Asian

[6] See Data Appendix for details. Quarterly data prior to 1975 are not available for economic activity for all the countries.

countries - in no case, the coefficient is lower than 0.83- and among local oil prices and $US prices except for the case of Malaysia -with a correlation coefficient of 0.56-.

The differential behavior of oil price movements before and after 1986 -the last period is characterized by large price declines and high volatility- and the apparent asymmetric response of economic activity indexes to oil price shocks in many economies have led researchers to explore different oil-output specifications in order to reestablish the relationship between these variables (see for example, Mork, 1989; Lee et al., 1995; Hamilton, 1996). Following this literature, we define the next four variables expressed both in $US and in each of the local currencies:

- Δoil_t: quarterly changes of real oil prices, that is, the conventional first difference transformation of oil price variables (in logs):

$$\Delta oil_t = \ln oil_t - \ln oil_{t-1}, \quad (1)$$

where oil_t is the real oil price in period t in $US or in local currency, as defined above. A significant relationship between this variable and economic activity would lead to a linear oil-output relationship.

- Δoil_t^+: real oil price increases,

$$\Delta oil_t^+ = max(0, \Delta oil_t), \quad (2)$$

In this case, we treat in a different way oil price increases and decreases, that is, we separate oil prices changes into negative and positive changes in a believe that oil price increases may have a significant effect on macroeconomic variables even though this might not occur for oil price decreases.

- $NOPI_t$: net oil price increases (expressed in real terms) defined as the quarterly percentage change in real oil price levels from the past 4 (and 12) quarters' high if that is positive and zero otherwise (NOPI4 and NOPI12). These variables are proposed by Hamilton (1996), who argues that if one wants a measure of how unsettling an increase in the price of oil is likely to be for the spending decisions of consumers and firms, it seems more appropriate to compare the current price of oil with where it has been over the previous years rather than during the previous quarter alone. Hamilton thus proposes to use the amount by which the log oil price in quarter t exceeds its maximum value over the previous periods; if oil prices are lower than they have been at some point during the most recent years, no oil shock is said to have occurred. That is,

$$
\begin{aligned}
NOPI4_t &= max\left[0,(\ln(oil_t)-\ln(max(oil_{t-1},oil_{t-2},oil_{t-3},oil_{t-4})))\right],\\
NOPI12_t &= max\left[0,(\ln(oil_t)-\ln(max(oil_{t-1},...,oil_{t-12})))\right]
\end{aligned}
\qquad (3)
$$

With this variable, we aim to check for a causal relationship between "important" oil price increases and macroeconomic variables.

- $SOPI_t$: scaled oil price increases (where oil price is expressed in real terms), proposed by Lee et al. (1995). They focus on volatility arguing that an oil shock is likely to have greater impact in an environment where oil prices have been stable than in an environment where oil price movements have been frequent and erratic because price changes in a volatile environment are likely to be soon reversed. In order to construct this variable, a GARCH(1,1) model is estimated:

$$
\begin{aligned}
&\Delta oil_t = \alpha + \sum_{j=1}^{k}\beta_j \Delta oil_{t-j} + \varepsilon_t \qquad \varepsilon_t \left| I_t \rightarrow N(0,h_t)\right.\\
&h_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1}\\
&SOPI_t = max(0, \hat{\varepsilon}_t / \sqrt{\hat{h}_t}).
\end{aligned}
\qquad (4)
$$

A significant relationship between this variable and economic activity implies that a "certain" oil price increase will cause a decrease in economic activity, while a price increase in a period of high volatility is less likely to cause it.

The oil price shock proxies (e.g., oil price increases, positive oil price increases, NOPI4 and SOPI) defined in $US are plotted in Figure 2[7] and the correlation coefficients among them are reported in Table 2. As we can see in the figure, the oil price shock proxies detect quite well the three main oil shocks in the period 1975Q1-2002Q2. The first one takes place in 1978-1979 when the Iranian revolution disrupted oil supplies and the price rose from $20 to $30. A second one followed Iraq´s invasion of Kuwait in 1990, when prices went from $16 to $26. Finally, prices grew up from $12 to $24 in 1999. However, we can also detect some differences among each of the variables. For example, we can observe that the variable Δoil^{+} takes a much higher value after the increase in oil prices after the invasion of Kuwait (see 1990Q3) than the NOPI variable, a difference which is due to the decrease in oil prices occurred in 1990Q2.

[Insert Figure 2]

[Insert Table 2]

3. Empirical analysis

In this Section we examine the oil price-macroeconomy relationship, by means of estimating the impact of oil prices on both economic activity and consumer price indexes for some Asian countries during the period 1975Q1-2002Q2.[8] The estimation strategy is as follows. First, we check for stationarity in each variable. Second, we analyze whether a long-run relation exists between the series testing for bivariate cointegration between

[7] Although all these variables are also constructed in the domestic currency of each of the Asian countries, we do not plot them but are available by request from the authors.

[8] Inflation rate (π) is calculated from Consumer Price Index (CPI) and economic activity (y) is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines.

oil prices and both CPI and production. Third, we study the short-run dynamic behavior between oil prices and macroeconomic variables checking for Granger causality. Finally, we test for asymmetries in the oil price changes and economic growth and inflation relationships.

a. Unit-root and cointegration results

As a first step of the empirical analysis, unit-root tests have been carried out for all of the variables: oil prices (both in $US and in local currencies), CPI and economic activity. Table 3 shows the results from applying the Phillips - Perron (1988) unit-root tests for each of the variables. The inspection of the results in Table 3 allows us to conclude that CPI, economic activity and oil prices may be considered integrated of order one (I(1)) variables in all countries.[9]

[Insert Table 3]

As all the variables exhibit a unit-root, we tested for bivariate cointegration using 2 alternative approaches. First, the Phillips - Ouliaris (1990) test based on the analysis of the stationarity of the residuals of the long-run relationship between the variables.[10]

---

[9] As shown in the table, we cannot reject the null hypothesis of unit-root, except for the case of the CPI in Japan when an intercept is included in the model. However, as we explain in Table 3, based on the temporal evolution of this series, its correlogram and the significativity of the time trend in the model with and intercept and a linear time trend (iii), we conclude that this variable is better characterized by an I(1) process. The same unit-root tests have been applied to the first differences of the variables (CPI, Oil prices and Economic Activity) and in all cases we rejected the null hypothesis of unit-root.

[10] Akaike´s information criterion (AIC) is used to determine the optimal lag length. Following Lutkepohl (1982) and McMillin (1991), AIC is used to the lag length of the cointegrating relationship. The optimal lag length chosen is one, which yields minimum AIC:

$$AIC = \log(\det\Sigma_k) + (2d^2k/T), \qquad k=1,2, ..., n$$

Second, in order to account for possible problems associated with structural breaks, we use the Gregory and Hansen (1996) test. Gregory and Hansen have developed residual-based cointegration tests that allow for an endogenously determined structural break in the cointegration relationship. We consider both a level shift and a level shift with trend models, which take the form[11]:

$$y_{1,t} = \alpha + \alpha_1 D_t + \beta y_{2,t} + u_t \, , \tag{5}$$

$$y_{1,t} = \alpha + \alpha_1 D_t + \beta y_{2,t} + \gamma t + u_t \, , \tag{6}$$

where D_t is the dummy variable

$$D_t = \begin{cases} 0, & if \quad t \le T_B \\ 1, & if \quad t > T_B \end{cases} ,$$

where the unknown parameter T_B denotes the timing of the change point; α represents the cointegrating intercept before the regime shift, α_1 denotes the change in the intercept at the time of the shift, β represents the cointegrating slope coefficient and t represents a linear time trend. Once we have estimated (5) and (6), the second step is to test if u_t is I(0) or I(1) via the Augmented Dickey Fuller or Phillips – Perron (1988) techniques. Tables 4 and 5 show the results of the bivariate cointegration tests between the world oil price in $US and each of the national oil prices and both CPI and economic activity. The general result of this analysis is that there is not a cointegrating long-run relationship

---

where d refers to the number of variable in the model; T is the number of observation; m refers to the maximum lag length considered; $\det\Sigma_k$ is the determinant of Σ_k; and Σ_k is the estimated residual variance-covariance matrix for lag k. Use of the AIC criterion suggests a lag length of 1 to 4 quarters for the estimated period 1975Q1-2002Q2. When we use the Schwarz´s criteria the results are similar and all the variables are I(1).

[11] In our case, economic activity and inflation rate ($y_{1,t}$) are regressed on oil prices ($y_{2,t}$).

between oil prices and economic activity, which suggests that the impact of oil shocks on these variables is limited to the short-run.[12] We do not find evidence of a long-run relationship between these variables even when we allow for a structural break.

[Insert Tables 4 and 5]

b. Granger causality tests

Since cointegration does not exist either between economic activity and oil prices or between consumer prices and oil prices, we use the following formulation in order to test for Granger causality from oil prices to economic growth rates and inflation rates, that is, we specify a short-run relationship between the variables estimating the following model in which all the variables are stationary:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \begin{Bmatrix} \Delta oil_{t-i} \\ \Delta oil^{+}_{t-i} \\ NOPI4_{t-i} \\ NOPI12_{t-i} \\ SOPI_{t-i} \end{Bmatrix} + \varepsilon_t , \quad (7)$$

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta CPI_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \begin{Bmatrix} \Delta oil_{t-i} \\ \Delta oil^{+}_{t-i} \\ NOPI4_{t-i} \\ NOPI12_{t-i} \\ SOPI_{t-i} \end{Bmatrix} + \varepsilon_t , \quad (8)$$

[12] As shown in the tables, we cannot reject the non cointegration null hypothesis, except for the oil prices-consumer price indexes relationship in Japan (when an intercept is included in the model and oil prices are expressed in $US). However, as we explain in Table 4 and based on the results of the unit-root tests in Table 3, the correlogram of the residuals of the long-run relationship between CPI and oil prices and the significativity of the time trend in model (iii), we conclude that there is no significant evidence to assume that cointegration exists between consumer and oil prices in Japan.

where Δ is the difference operator, k is the number of lags (chosen according to the AIC criteria), the dependent variable are both the growth rate of production and the inflation rates, and as explanatory variables we include lagged values of the dependent variable and of each of the constructed proxies of oil price shocks (Δoil, Δoil^+, NOPI4, NOPI12, SOPI).[13]

Failing to reject the null hypothesis $\alpha_{21}=\alpha_{22}=...=\alpha_{2k}=0$ implies that oil price changes do not Granger cause economic growth or inflation rates. Table 6 shows the results of these Granger causality tests from oil price shocks expressed in $US to economic growth rates. According to these results, oil price changes do not cause economic growth rates in any of the countries. However, when the alternative proxy variables of oil shocks are used, a significant relationship is found in the cases of Japan and South Korea. Therefore, there seems to be a short-run relationship between oil prices in $US and economic activity, in which oil price changes affect economic growth rates, although the relationship is more likely to be asymmetric and non-linear than linear. In Section 3c we test for asymmetries in the oil prices-macroeconomy relationship.

However, when oil prices are expressed in local currency (see Table 7), we find evidence of Granger causality from oil price shocks to economic growth rates in Japan, South Korea and Thailand, when we allow for nonlinear transformations of oil prices. Furthermore, the relationship between oil price shocks and economic growth rates is more significant when oil price shocks are defined in local currency than when defined in $US.

[Insert Tables 6 and 7]

[13] Recall that the defined proxy variables for oil price changes are stationary transformations of oil prices in $US and in each of the domestic currencies, which are I(1) variables.

As far as the oil prices-consumer price indexes relationship is concerned, Table 8 presents the Granger causality tests from oil price shocks expressed in $US to inflation rates. Based on these results, we find evidence of causality from oil price shocks to inflation rates in the cases of Japan, Singapore and Thailand. When we define oil price shocks in local currency (see Table 9), we find evidence of causality for all six Asian economies. As before, the relationship between oil price shocks and inflation rates is more significant when oil price shocks are defined in domestic currencies and when a non-linear relationship is specified between the two variables.

[Insert Tables 8 and 9]

c. Testing for asymmetric effects

The asymmetric relationship between oil price shocks and macroeconomic variables is investigated in many papers. For example, several studies find that rising oil prices seem to retard economic activity by more than falling oil prices stimulate it (see for example Mork, 1989; Lee et al., 1995; Hamilton, 1996; Davis and Haltiwanger, 2001, for the US case and Mork et al., 1994, for seven OECD countries).

In this paper, and in order to test for asymmetries, we follow Mork (1989) and Mork et al. (1994) and enter in the same equation real oil price increases and decreases as separate variables determining economic growth and inflation rates. Thus, our bivariate estimation equations are:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{k} \alpha_{2i}^{+} \Delta oil_{t-i}^{+} + \sum_{i=1}^{k} \alpha_{2i}^{-} \Delta oil_{t-i}^{-} + \varepsilon_t, \tag{9}$$

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta CPI_{t-i} + \sum_{i=1}^{k} \alpha_{2i}^{+} \Delta oil_{t-i}^{+} + \sum_{i=1}^{k} \alpha_{2i}^{-} \Delta oil_{t-i}^{-} + \varepsilon_t, \tag{10}$$

where Δoil^- are price decreases, that is, it equals the oil-price growth rate when it is negative and it is 0 otherwise, i.e.

$$\Delta oil_t^- = min(0, \Delta oil_t). \tag{11}$$

With this specification, we can carry out conventional tests of the following hypotheses:

$$\alpha_{2i}^+ = \alpha_{2i}^-, \quad i = 1,2,...k. \tag{12}$$

In Tables 10 and 11 we display the results obtained by carrying out this test of pairwise equality of the coefficients. As far as the economic growth rate-oil price changes relationship is concerned, the main results suggest that there is evidence of an asymmetric relationship only for the case of South Korea when oil prices are measured in domestic currency.

Moreover, we estimate equations (9) and (10) including net oil price increases (NOPI) together with oil price decreases and test whether each of the coefficients of NOPI variables is equal to its corresponding coefficient of oil price decreases, i.e., we test the null hypothesis (12). In this case, as shown in Tables 10 and 11, we also find evidence of an asymmetric relationship between inflation rate and oil price changes in the cases of South Korea and Malaysia.

[Insert Tables 10 and 11]

4. Concluding remarks

This paper analyzes the oil prices-macroeconomy relationship by means of studying the impact of oil price shocks on both inflation and economic growth rates for some Asian countries over the period 1975Q1-2002Q2. Besides the relevance of this analysis in the context of the new oil shock occurred in 2000, the major contribution of this paper is the use of different oil-output and oil-CPI specifications in order to measure the impact of oil prices on both inflation and economic growth rates for some Asian countries. The main results may be summarized as follows.

First, we obtain different results depending on whether we use a world real oil price (expressed in $US) or a local real oil price for each of the countries measured in the domestic currency. In fact, the impact is higher when oil prices are measured in local currency, which could be due to the role of exchange rates or national price variations on macroeconomic variables.

Second, there is not a cointegrating long-run relationship between oil prices and economic activity, which suggests that the impact of oil shocks on these variables is limited to the short-run. We do not find evidence of a long-run relationship between these variables even when we allow for a structural break around mid-eighties in order to capture the oil market collapse occurred around 1985.

Third, when analyzing short-run relationships between oil prices and economic growth rates, oil price shocks are found to Granger cause economic growth rates in Japan, South Korea and Thailand (in the last case, only when oil prices are defined in local currency) when several non-linear specifications are used to model the relationship between the variables.

Fourth, and as far as the inflation rates are concerned, we find that oil price shocks expressed in local currencies have a significant effect on inflation in all analyzed countries. As before, the oil prices-consumer prices relationship appears to be limited to the short-run and more significant when oil price shocks are defined in local currencies.

Fifth, we find evidence of asymmetries in the oil price changes-inflation rate relationship for the cases of Japan, Thailand, South Korea and Malaysia, and only for the case of South Korea when the oil price changes-economic growth rate relationship is analyzed. Furthermore, the oil prices-consumer prices relationship appears to be more significant and more general than the oil prices-economic activity relationship for the Asian countries. Finally, we find some differences among the responses of each of the Asian countries to oil price shocks. For example, the oil prices-macroeconomy relationship seems to be less significant for the case of Malaysia (the only oil-importing country in the sample) than for the rest of the economies. However, although the results seem to suggest that the response of the oil-exporting countries may differ from that of oil importers, it is difficult to reach significant results from this sole result and further research is needed to obtain a more reliable conclusion.

Data Appendix

The quarterly data used in this study are mainly obtained from International Financial Statistics CDROM and cover the period 1975Q1-2002Q2. The countries included in the study are Japan, Singapore, South Korea, Malaysia, Thailand and Philippines. The variables are:

- Real oil price levels: the world oil price is calculated as the ratio between the producer price index for crude oil divided by the producer price index for all commodities. The oil prices measured in national currencies are obtained using the exchange rate of each of the countries. These variables are deflated using the consumer price index of each of the countries.
- Exchange rate (e): e is the exchange rate for each Asian country against the $US; because oil price is expressed in $US it was converted to local currencies using the

average market exchange rates for the quarter.

- Inflation rates: calculated from Consumer Price Index (CPI), seasonally adjusted.

- Economic activity: proxied by Industrial Production Index for Japan and South Korea and Manufacturing Production Index for Singapore, seasonally adjusted. For the three ASEAN-4 countries (Malaysia, Thailand and Philippines) we use the quarterly real GDP series constructed in Abeysinghe (2001). The first three series were available in seasonally adjusted form and the others were seasonally adjusted using X-12 procedure.

References

Abeysinghe, T. (2001). Estimation of direct and indirect impact of oil price on growth. *Economic Letters* 73, 147-153.

Brown, S.P.A., & Yücel, M.K. (2002). Energy prices and agregate economic activity: and interpretative survey. *The Quaterly Review of Economic and Finance* 42, 193-208.

Bruno, M., & Sachs, J. (1982). Input price shocks and the slowdown in economic growth: the case of U.K. manufacturing. *Review of Economic Studies* 49, 679-705.

Burbidge, J., & A. Harrison. (1984). Testing for the effects of oil-price rises using vector autoregression. *International Economic Review* 25, 459-484.

Caruth, A.A., Hooker, M.A., & Oswald, A.J. (1998). Unemployment equilibria and input prices: theory and evidence from the United States. *Review of Economics and Statistic* 80, 621-628.

Davis, S.J. (1986). Allocative disturbances and temporal asymmetry in labor market fluctuations. *University of Chicago*, mimeo.

Davis, S.J., & Haltiwanger, J. (2001). Sectoral job creation and destruction responses to oil price changes. *Journal of Monetary Economics* 48, 465-512.

Ferderer, J.P. (1996). Oil price volatility and the Macroeconomy: A solution to the asymmetry puzzle. *Journal of Macroeconomics* 18, 1-16.

Gregory, A., & Hansen, B. (1996). Residual based tests for cointegration in models with regime shifts. *Journal of Econometrics* 70, 99-126.

Hamilton, J. (1983). Oil and the macroeconomy since World War II. *Journal of Political Economy* 91, 593-617.

Hamilton, J. (1988). A neoclassical model of unemployment and the business cycle. *Journal of Political Economy* 96, 593-617.

Hamilton, J. (1996). This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economy* 38, 215-220.

Hamilton, J. (2000). What is an oil shock?. *NBER working paper* 7755.

Hooker, M. (1996) What happened to the oil price-macroeconomy relationship?. *Journal of Monetary Economics* 38, 195-213.

Hooker, M. (1999). Oil and the macroeconomy revisited. *Federal Reserve Board*, mimeo.

Hooker, M. (2002). Are oil shocks inflationary? Asymetric and nonlinear specifications versus change in regime. *Journal of Money, Credit and Banking* 34, 540-561.

Huntington, H. (1998). Crude oil prices and U.S. economic performance: Where does the asymmetry reside?. *Energy Journal* 19, 107-32.

Hutchison, M.M. (1993). Structural change and the macroeconomic effects of oil shocks: empirical evidence from the United States and Japan. *Journal of International Money and Finance* 12, 587-606.

Kahn, G., & Hampton, R. (1990). Possible monetary policy responses to the Iraqui oil shock. *Federal Reserve Bank of Kansas City Economic Review* 2, 19-32.

Kim, I., & Loungani, P. (1992). The role of energy in real business cycle models. *Journal of Monetary Economics* 29, 173-189.

Lee, K., Ni, S., & Ratti, R.A. (1995). Oil shocks and the macroeconomy: The role of price variability. *Energy Journal* 16, 39-56.

Lee, B.R., Lee, K., & Ratti, R.A. (2001). Monetary policy, oil price shocks and the Japanese economy. *Japan and the World Economy* 13, 321-349.

Lutkepohl, H. (1982). Non-causality due to omitted variables. *Journal of Econometrics* 19, 367-378.

McMillin, W. (1991). The velocity of M1 in the 1980s: Evidence from a multivariate time series model. *Southern Economic Journal* 57, 711-648.

Mork, K. (1989). Oil and the macroeconomy when prices go up and down: An extension of Hamilton´s resuls. *Journal of Political Economy* 97, 740-744.

Mork, K. (1994). Business cycles and the oil market. *Energy Journal* 15, 15-38.

Mork, K., Olsen, O., & Mysen, H.T. (1994). Macroeconomic responses to oil price increases and decreases in seven OECD countries. *Energy Journal* 15, 15-38

Phelps, E.S. (1994). *Structural Slumps*. Cambridge: Harvard University Press.

Phillips, P.C.B., & Ouliaris, S. (1990). Asymptotic properties of residual-based test for cointegration. *Econometrica* 58, 165-193.

Phillips, P.C.B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika,* 75 335-346.

Rasche, R.H. & Tatom, J.A. (1981). Energy price shocks, aggregate supply and monetary policy: The theory and International Evidence. *Carnegie - Rochester Conference Series on Public Policy* 14, 125-142.

Takenaka, H. (1991). *Contemporary Japanese Econmy and Economic Policy*. University of Michigan Press.

Tatom, J. (1988). Are the macroeconomic effects of oil price changes symmetric?. *Carnegie - Rochester Conference Series on Public Policy* 28, 325-368.

Zivot, E., & Andrews, D. (1992). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business and Economic Statistics* 10, 251-270.

Table 1
Correlation coefficients among real domestic oil prices and world oil prices

	Singapore	South Korea	Malaysia	Thailand	Philippines	World
Japan	0.95	0.95	0.92	0.89	0.88	0.75
Singapore		0.97	0.91	0.96	0.95	0.78
South Korea			0.89	0.96	0.94	0.83
Malaysia				0.86	0.83	0.56
Thailand					0.94	0.85
Philippines						0.84

Note: real domestic oil prices are defined as oil prices expressed in local currency and in real terms; world oil price is defined as the producer oil price index in real terms and expressed in $US.

Table 2

Correlation coefficients among oil price proxies

	Δoil^+	NOPI4	NOPI12	SOPI
Δoil	0.81	0.65	0.51	0.73
Δoil^+		0.84	0.66	0.82
NOPI4			0.84	0.71
NOPI12				0.56

Notes: Δoil: real oil price changes, Δoil^+: positive real oil price changes, NOPI4: net real oil price increase with 4 quarters, NOPI12: net real oil price increase with 12 quarters, and SOPI: scaled real oil price increase. All these proxies have been constructed using the oil price variable defined in $US.

Table 3
Unit root tests: Phillips - Perron

	CPI			Oil Prices			Economic Activity		
	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
Japan	2.73	-5.75**	-1.72	-1.04	-1.53	-2.29	1.11	-0.79	-0.79
Singapore	3.67	-1.17	-1.31	-0.76	-1.89	-2.64	2.12	-2.25	-2.25
S. Korea	5.35	0.05	-1.90	-0.94	-2.05	-2.56	4.68	-1.13	-1.13
Malaysia	7.37	0.47	-1.77	-1.25	-1.71	-2.63	4.91	-1.55	-1.55
Thailand	5.55	0.14	-1.83	-0.64	-2.40	-2.71	2.87	-1.74	-1.74
Philippines	8.15	3.51	-1.72	-0.76	-2.47	-3.05	4.27	0.10	0.10
World	--	--	--	-0.36	-2.27	-2.39	--	--	--

Notes: CPI is consumer price index; Oil Prices is defined as the real oil price expressed in local currency for each of the Asian countries except for World oil price (expressed in $US); Economic Activity is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines.
(i): with no regressors; (ii): with an intercept; (iii) with an intercept and a linear time trend.
** mean that the unit root test hypothesis is rejected at 5%.
In any of the cases we can reject the null hypothesis of unit-root, except for the case of the CPI in Japan when an intercept is included in the model. However, based on the temporal evolution of this series, its correlogram and the significativity of the time trend in model (iii), we conclude that this variable is better characterized by an I(1) process. The same unit-root tests have been applied to the first differences of the variables (CPI, Oil Prices and Economic Activity) and in all cases we rejected the null hypothesis of unit-root.
The number of the lags included was determined using Akaike Information Criteria (AIC).

Table 4
Cointegration tests (world oil price)

	Phillips-Ouliaris#				Gregory – Hansen##			
	CPI		Ec. Activity		CPI		Economic Activity	
	(ii)	(iii)	(ii)	(iii)	(iv)	(v)	(iv)	(v)
Japan	-4.74**	-2.18	-2.35	-2.56	-3.71 (1986Q2)	-3.80 (1986Q3)	-4.12 (1986Q3)	-3.87 (1986Q3)
Singapore	-1.23	-1.64	-0.74	-2.41	-2.66 (1986Q3)	-2.70 (1986Q2)	-2.95 (1992Q1)	-2.98 (1990Q4)
S. Korea	-0.48	-1.81	0.24	-2.10	-2.37 (1992Q2)	-2.36 (1990Q4)	-2.70 (1992Q2)	-2.67 (1992Q2)
Malaysia	-0.17	-1.53	-0.27	-2.16	-2.29 (1992Q3)	-2.28 (1992Q3)	-2.83 (1992Q2)	-2.79 (1992Q3)
Thailand	-0.35	-1.72	-0.97	-2.64	-2.32 (1992Q3)	-2.29 (1992Q3)	-2.75 (1990Q4)	-2.72 (1990Q4)
Philippines	0.68	-1.57	0.61	-1.43	-2.51 (1992Q4)	-2.48 (1993Q2)	-2.72 (1993Q1)	-2.72 (1993Q2)

Notes: CPI is consumer price index; Oil Prices is defined as the world oil price expressed in real terms and in $US; Economic Activity is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines.
(ii): with an intercept; (iii) with an intercept and a linear time trend.
(iv): level shift model; (v): level shift with trend model.
The date of the break in parentheses.
The critical values are taken from Phillips-Ouliaris (1990).
** mean that the non cointegration null hypothesis is rejected at 5%. Again, and for the case of Japan, and based on the results of the unit root tests in Table 3, the correlogram of the residuals of the long-run relationship between CPI and oil prices and the significativity of the time trend in model (iii), we conclude that there is no significant evidence to assume that cointegration exists between consumer and oil prices in Japan.
The critical values are taken from Gregory and Hansen (1996).

Table 5
Cointegration tests (local oil prices)

	Phillips-Ouliaris#				Gregory – Hansen##			
	CPI		Ec. Activity		CPI		Economic Activity	
	(ii)	(iii)	(ii)	(iii)	(iv)	(v)	(iv)	(v)
Japan	-2.68	-2.37	-2.69	-2.56	-3.31 (1990Q2)	-3.28 (1990Q4)	-3.37 (1982Q3)	-4.31 (1980Q2)
Singapore	-1.98	-2.27	-1.71	-2.41	-2.50 (1978Q4)	-2.53 (1985Q3)	-3.02 (1992Q4)	-2.96 (1993Q3)
S. Korea	-1.25	-2.21	-0.76	-2.10	-2.51 (1992Q3)	-2.58 (1990Q4)	-3.18 (1992Q2)	-3.30 (1992Q3)
Malaysia	-1.31	-2.04	-1.33	-2.16	-2.84 (1996Q4)	-3.26 (1997Q3)	-3.03 (1992Q4)	-3.17 (1991Q4)
Thailand	-1.04	-2.20	-1.35	-2.64	-2.45 (1996Q3)	-2.43 (1997Q2)	-2.92 (1990Q4)	-2.98 (1990Q4)
Philippines	-1.15	-2.71	-0.52	-1.43	-2.60 (1997Q3)	-2.61 (1998Q1)	-2.61 (1993Q1)	-2.68 (1998Q1)

Notes: CPI is consumer price index; Oil Prices is defined as the real oil price expressed in local currency for each of the Asian countries; Economic Activity (y) is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines.
(ii): with an intercept; (iii) with an intercept and a linear time trend.
The date of the break in parentheses.The date of the break in parentheses.
The critical values are taken from Phillips-Ouliaris (1990).
The critical values are taken Gregory and Hansen (1996).

Table 6
Granger causality tests from oil prices (expressed in $US) to economic growth rates

	Δoil	Δoil^{+}	NOPI4	NOPI12	SOPI
Japan	1.90	1.41	3.05*	0.51	0.87
Singapore	0.18	0.60	0.85	1.05	1.35
South Korea	1.02	2.06	0.48	2.13	3.92*
Malaysia	1.51	0.71	0.55	0.49	0.85
Thailand	0.58	0.39	0.85	0.58	0.36
Philippines	0.35	1.45	2.00	1.05	0.58

Notes: Δoil: real oil price changes; Δ oil*e: real oil price changes expressed in local currency; Δoil^{+}: positive oil price changes; NOPI4: net oil price increase with 4 quarters; NOPI12: net oil price increase with 12 quarters; SOPI: scaled oil price increase; y is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines. The four oil price proxies have been defined using oil price variables expressed in $US.
The number of the lags included was determined according to the AIC criteria.
The null hypothesis that lag values of oil price shocks are not significant in explaining economic growth rates is tested (see equation (7)). * indicates significant at 10%.

Table 7
Granger causality tests from oil prices (in domestic currencies) to economic growth rates

	Δoil	Δoil^{+}	NOPI4	NOPI12	SOPI
Japan	1.29	2.88*	1.26	2.19	2.80*
Singapore	0.72	0.76	0.98	2.14	0.78
South Korea	1.97	6.87**	1.01	11.03**	6.84**
Malaysia	0.69	0.55	0.24	1.04	0.10
Thailand	1.09	2.45	0.17	4.26**	0.25
Philippines	0.23	0.01	0.07	0.38	0.03

Notes: Δoil: real oil price changes; Δ oil*e: real oil price changes expressed in local currency; Δoil^{+}: positive oil price changes; NOPI4: net oil price increase with 4 quarters; NOPI12: net oil price increase with 12 quarters; SOPI: scaled oil price increase; Economic Activity is proxied by Industrial Production Index in Japan and South Korea, Manufacturing Production Index in Singapore, and quarterly real GDP in Malaysia, Thailand and Philippines. Each of the oil price proxies have been defined using oil price variables expressed in local currencies.
The number of lags have been chosen according to the AIC criteria.
The null hypothesis that lag values of oil price shocks are not significant in explaining economic growth rates is tested (see equation (7)). * and ** indicate significant at 10 and 5% respectively.

Table 8
Granger causality tests from oil prices (expressed in $US) to inflation

	Δoil	Δoil$^+$	NOPI4	NOPI12	SOPI
Japan	3.74**	4.09**	3.72**	3.57**	2.02*
Singapore	1.82	2.01*	1.99	2.92*	1.35
South Korea	1.76	1.20	0.54	1.25	1.10
Malaysia	0.72	0.90	0.62	1.59	0.45
Thailand	1.70	2.37*	3.20**	3.68**	1.45
Philippines	0.90	1.18	1.32	1.40	1.39

Notes: Δoil: oil price changes; Δ oil*e: real oil price changes expressed in domestic currency; Δoil$^+$: positive oil price changes; NOPI4: net oil price increase with 4 quarters; NOPI12: net oil price increase with 12 quarters; SOPI: scaled oil price increase; inflation is defined as the growth rate of CPI. The four oil price proxies have been defined using oil price variables expressed in $US.

The number of lags have been chosen according to the AIC criteria.

The null hypothesis that lag values of oil price shocks are not significant in explaining changes in inflation rates is tested (see equation (8)). * and ** indicate significant at 10 and 5% respectively.

Table 9
Granger causality tests from oil prices (expressed in domestic currencies) to inflation

	Δoil	Δoil^+	NOPI4	NOPI12	SOPI
Japan	5.12**	6.00**	5.01**	4.02**	8.00**
Singapore	2.16*	1.40	2.02*	2.14*	2.63**
South Korea	5.41**	1.04	2.15*	4.30**	1.50
Malaysia	1.37	2.38*	0.83	2.48**	1.02
Thailand	3.23**	2.51*	3.18**	3.92**	3.87**
Philippines	2.17*	1.82	0.86	3.37**	2.37*

Notes: Δoil: oil price changes; Δoil*e: real oil price changes expressed in domestic currency; Δoil^+: positive oil price changes; NOPI4: net oil price increase with 4 quarters; NOPI12: net oil price increase with 12 quarters; SOPI: scaled oil price increase; inflation is defined as the growth rate of CPI. Each of the oil price proxies have been defined using oil price variables expressed in local currencies.
The number of lags have been chosen according to the AIC criteria.
The null hypothesis that lag values of oil price shocks are not significant in explaining changes in inflation rates is tested (see equation (8)). * and ** indicate significant at 10 and 5% respectively.

Table 10
Testing for asymmetric effects of oil prices (expressed in $US)

	Inflation rate (ΔCPI)			Economic growth rate (Δy)		
	$\alpha_2^+ = \alpha_2^-$	$\alpha_2^{NOPI4} = \alpha_2^-$	$\alpha_2^{NOPI12} = \alpha_2^-$	$\alpha_2^+ = \alpha_2^-$	$\alpha_2^{NOPI4} = \alpha_2^-$	$\alpha_2^{NOPI12} = \alpha_2^-$
Japan	7.54*	5.93	3.11	0.62	1.20	1.25
Singapore	5.51	3.69	6.11	1.52	1.37	1.30
South Korea	6.16	11.38**	10.30**	1.12	0.72	2.53
Malaysia	6.70	7.27	10.83**	0.01	0.18	0.25
Thailand	8.53*	8.30*	9.22*	1.17	1.20	0.35
Philippines	0.74	0.88	2.31	1.13	0.90	1.79

Notes: α_2^+ is the coefficient of Δoil^+(positive oil price increases) in equations (9) and (10); α_2^- is the coefficient of Δoil^- (oil price decreases) in equations (9) and (10); α_2^{NOPI4} is the coefficient of NOPI4 (net oil price increases) in equations (9) and (10); α_2^{NOPI12} is the coefficient of NOPI12 in equations (9) and (10).
The number of lags have been chosen according to the AIC criteria.
The carry out conventional Chi-square tests of the null hypothesis (12).
* and ** indicate significant at 10 and 5% respectively.

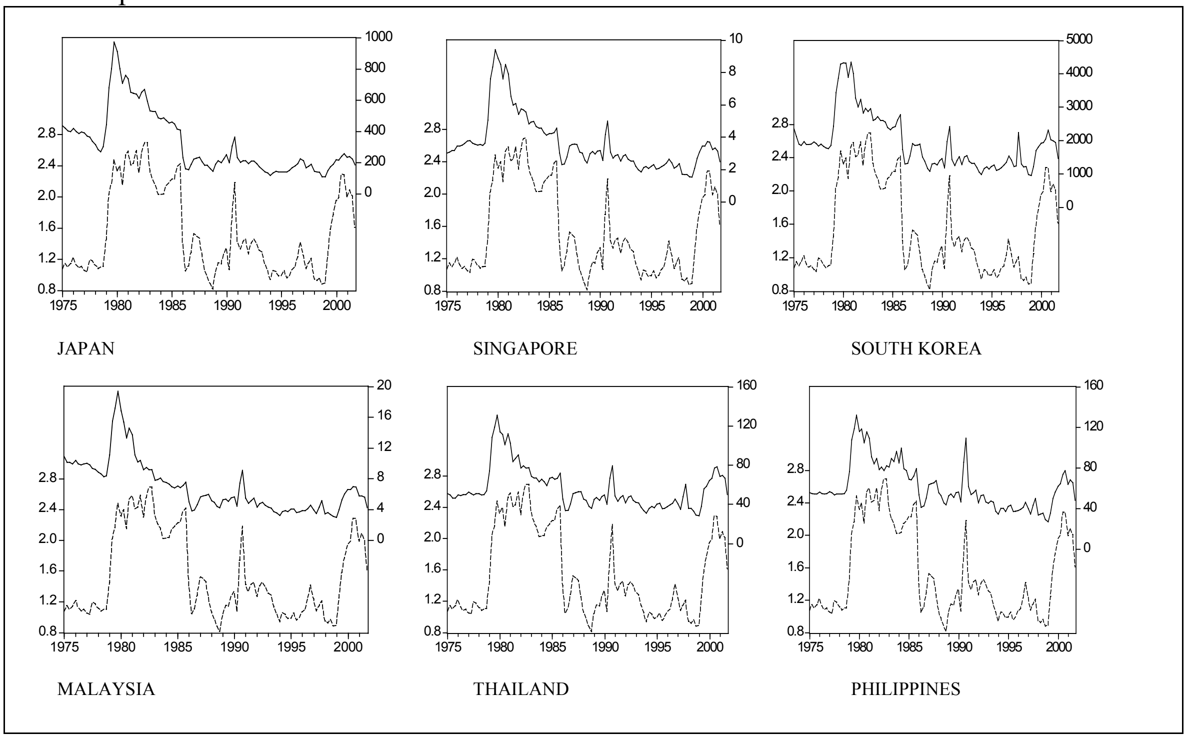
Table 11
Testing for asymmetric effects of oil prices (expressed in domestic currencies)

	Inflation rate (ΔCPI)			Economic growth rate (Δy)		
	$\alpha_2^+ = \alpha_2^-$	$\alpha_2^{NOPI4} = \alpha_2^-$	$\alpha_2^{NOPI12} = \alpha_2^-$	$\alpha_2^+ = \alpha_2^-$	$\alpha_2^{NOPI4} = \alpha_2^-$	$\alpha_2^{NOPI12} = \alpha_2^-$
Japan	7.89**	6.42	5.87	2.65	1.22	3.29
Singapore	2.65	3.36	5.59	1.98	2.18	3.00
South Korea	5.65	8.29*	10.42**	9.35**	1.21	14.31**
Malaysia	5.12	4.35	7.77**	0.77	0.03	1.16
Thailand	9.45**	7.98**	8.04**	1.75	0.29	2.65
Philippines	4.79	3.22	2.11	0.83	0.52	0.72

Notes: α_2^+ is the coefficient of Δoil^+(positive oil price increases) in equations (9) and (10); α_2^- is the coefficient of Δoil^- (oil price decreases) in equations (9)and (10); α_2^{NOPI4} is the coefficient of NOPI4 (net oil price increases) in equations (9)and (10); α_2^{NOPI12} is the coefficient of NOPI12 in equations (9) and (10).

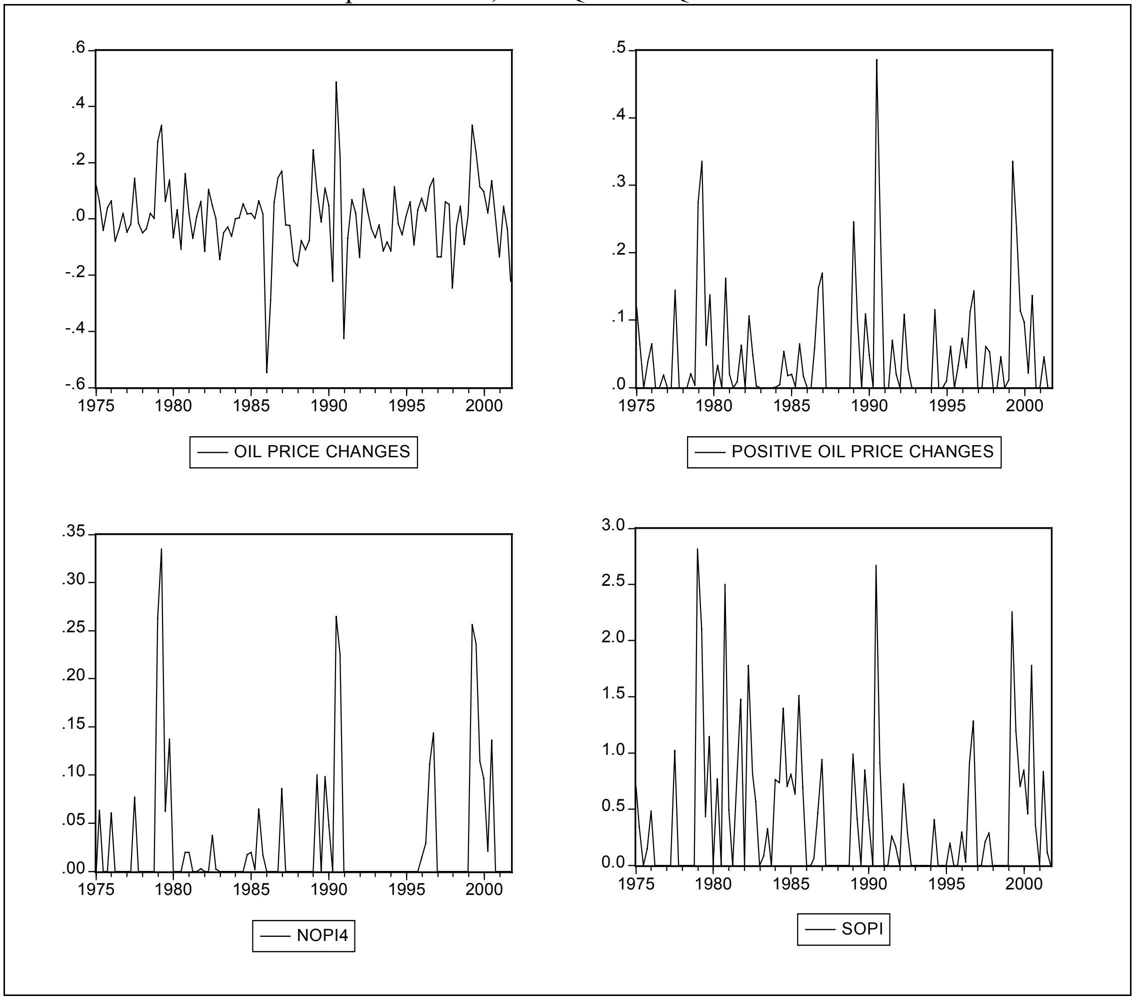
The number of lags have been chosen according to the AIC criteria.
The carry out conventional Chi-square tests of the null hypothesis (12).
* and ** indicate significant at 10 and 5% respectively.

Figure 1
Real oil prices in local currencies and in dollars



Real oil prices for the Asian countries are defined as deflacted oil prices and expressed in local currency (solid lines). Real oil price in $US is defined as the ratio between the producer price index for crude oil divided by the producer price index for all commodities (dashed line).

Figure 2
Alternative measures of oil price shocks, 1975Q1-2002Q2



The first figure represents the oil price changes (Δoil), the second one the positive oil price changes (Δoil^+) and the last two figures represent the evolution of NOPI4 and SOPI variables calculated as described in Section 2. Although these proxy variables have been calculated in $US and in each of the local currencies, we only display the evolution of the variables expressed in $US.