Sosyo Ekonomi

July-December 2013-2

Oil Price Fluctuations and Changing Comparative Advantage

Mukhriz Izraf Azman AZIZ
mukhriz@uum.edu.my

Nor'Aznin Abu BAKAR
noraznin@uum.edu.my

Petrol Fiyatlarındaki Dalgalanmalar ve Değişen Mukayeseli Üstünlükler

Abstract

This paper attempts to quantify the effects of oil price fluctuations on revealed comparative advantage (RCA) for 36 manufacturing commodities of 167 countries over a 16-year period from 1990 to 2005. Using Zellner's (1962) seemingly unrelated regression (SURE) model, the negative effects of oil price fluctuations on RCA vary according to objectives and model specification. Oil price fluctuations negatively affect manufacturing commodities' RCA in 1997-2005 more than in 1990-1996 periods. The paper also found that oil price fluctuations negatively affect middle-income economies and net oil-exporting countries' RCA more than high-income economies and net oil-importing countries.

Keywords : Revealed Comparative Advantage, Oil Price Shocks, International Trade.

JEL Classification Codes : C33, F11, N50.

Özet

Bu çalışma petrol fiyatlarındaki dalgalanmaların 1990–2005 yılları arasındaki 16 yıllık dönemde ve 167 ülkedeki 36 kalem imalat sanayi ürünü üzerindeki etkisini Açıklanmış Mukayeseli Üstünlükler (RCA) endeksiyle sayısallaştırmaya yöneliktir. Zellner'in (1962) SURE modeli kullanıldığında petrol fiyatlarındaki dalgalanmaların RCA endeksi üzerindeki olumsuz etkisi nesnel olarak ve model özelliklerine göre farklılaşmaktadır. Petrol fiyatlarındaki dalgalanmalar 1990–1996 yıllarına göre 1997–2005 yılları arasında imalat sanayi ürünlerinin RCA endeksini daha da olumsuz etkilemiştir. Bu çalışmada ayrıca yüksek gelirli ülkelere ve net petrol ithalatçısı ülkelere göre petrol fiyatlarındaki dalgalanmaların orta gelirli ülkeler ile net petrol ihracatçısı ülkelerin RCA endeksini daha olumsuz etkilediğini ortaya koymaktadır.

Anahtar Sözcükler : Açıklanmış Mukayeseli Üstünlükler, Petrol Fiyatı Şokları, Uluslararası Ticaret.

1. Introduction

Oil has a unique position in the world's economic system. It is a vital source of energy and an essential raw material in many manufacturing processes. Over the period 1990–2005, the price of crude oil fluctuated significantly, with mean, minimum, and maximum values of US$21.70, US$12.09, and US$49.20 a barrel respectively. The above statistics, in addition to a standard deviation of US$8.90 per barrel over the same period, show that the price of crude has always been characterized by instability. Such instability is bound to cause macroeconomic distortions. Various studies, such as those of Rasche and Tatom (1977, 1981), Burbidge and Harrison (1984), Hamilton (1983), Mork (1989), Gisser and Goodwin (1986), and Lee et al. (1995), have provided empirical evidence that rising oil prices reduce output and increase inflation.

When oil prices rise suddenly, the overall inflation rate is temporarily pushed up because other prices do not instantly adjust and fall. At the same time, because energy is an important input in the manufacturing production process, the price shock raises the cost of production. Since other prices do not instantly fall, the overall cost of production rises and producers must cut back production, which causes a contraction in output and employment, all else being equal. There may also be adjustment costs to shifting towards less energy-intensive methods of production, and these could temporarily have a negative effect on output. The most extensively explored theories on the direct effects of oil price fluctuations on production costs include the *input-cost effect*, in which a higher energy cost lowers oil usage that in turn lowers productivity in terms of capital and labour, and the *income effect*, whereby a higher cost of imported oil reduces the disposable income of households.

For producers, the *input-cost effects* of fluctuations in oil prices may affect revenue, expenditure, and comparative advantage (and therefore the international trade position) of their firms. The Ricardian and Heckscher-Ohlin (H-O) theories are the two workhorse models used to explain comparative advantage in trade. The Ricardian model of international trade predicts that countries specialize in goods in which they hold the greatest relative advantage in labour productivity. The H-O model ignores differences in labour productivity across industries and asserts that differences in comparative advantage come from differences in factor abundance and in the factor intensity of goods. The differences in sources of comparative advantage proposed via these two trade theories suggest that comparative advantage could change if there are changes in labour productivity or the composition of capital and labour in the production of goods.

As noted by Bhagwati (1998), comparative advantage can also change when there are variations in production costs, a phenomenon referred to as "kaleidoscope" or "knife-edge" comparative advantage. For example, when oil prices increase, the inelastic demand curve for oil means that total spending on oil imports increases. This puts pressure on the exchange rate and depreciates the local currency. This depreciation, in turn, may affect trade performance and hence the comparative advantage of producers. Even if depreciation increases the aggregate demand for oil-importing countries, prices may increase owing to the exchange rate pass-through, and lower output may occur through higher input costs (Berument et al., 2005). Hunt, Isard, and Laxton (2001) add that an increase in input costs due to increased oil price can drive down non-oil potential output supplied in the short run given existing capital stock and sticky wages.

The fact that comparative advantage can change when there are variations in production costs, productivity, or composition of inputs suggests a possible causality running from oil price fluctuations to comparative advantage. Although many researchers have considered the relationship between oil price movements and macroeconomic variables in the last few decades, no study substantiates the role of oil price changes on comparative advantage. Therefore, the main purpose of the present study is to investigate the impact of oil price fluctuations on countries' comparative advantage. As pre-trade data are difficult to observe,[1] the estimation of comparative advantage is often based on post-trade values. Accordingly, this paper employs the "revealed comparative advantage" (RCA) approach of Balassa (1965, 1977) who assumed that the true pattern of comparative advantage can be observed from post-trade data.

In this paper, the analysis of oil price fluctuations on RCA is centred within the manufacturing sector. This sector is a major structural component of total economic activity, often regarded as the basic driving force of economic activity. Manufacturing production is chosen as the output measure since oil prices should be linked most closely to the manufacturing sector. While manufacturing sectors depend largely on the development of skills and equipment, its activities also draw from a wide range of resources and raw materials, such as oil, that are subject to fluctuations both in terms of price and input supply. In terms of energy use, it is well known that energy intensity in the manufacturing sector is higher than in any other sector. As world oil prices continue to increase, this imposes constraints on the manufacturing sector's growth, hence affecting manufacturers' comparative advantage.

To estimate the impacts of oil price fluctuations on RCA, this paper adopts an unrestricted system of equations for 167 countries using annual panel data from 1990 to

---

[1] *Except in the case of Bernhofen (2004), who provided the first direct test of the theory of comparative advantage in terms of a country's relative autarky prices for the case of Japan in the nineteenth century. Based on the correlation version of the law of comparative advantage developed by Deardorff (1980), Bernhofen (2004) found that Japan's autarky price value of trade is negative for each single year of the sample period 1868–75. This provides strong empirical support for the prediction of the theory of comparative advantage at autarky price (or pre-trade price).*

2005 for 36 RCA indices. The 36 RCA indices are derived from 36 exports of manufacturing commodities from UN Standard International Trade Classification (SITC) trade data at the two-digit level. The paper then divides these 36 RCA indices into four groups according to Krause's (1987) factor content commodity classification system. Using Krause's specification, there are 14 (RCA) commodities in the capital-intensive group, 8 (RCA) commodities in the skilled-labour group, 6 (RCA) commodities in the unskilled-labour group, and 8 (RCA) commodities in the natural-resource-intensive group. With each classification representing a system of equations, the paper employs Zellner's (1962) "seemingly unrelated regression" (SURE) model to estimate the impacts of oil price fluctuations on RCA.

This paper is organized as follows. Section 2 provides a theoretical background to the theory of comparative advantage and discusses how oil price fluctuations may affect RCA. Data and methods are discussed in section 3. Section 4 discusses the empirical results and section 5 concludes.

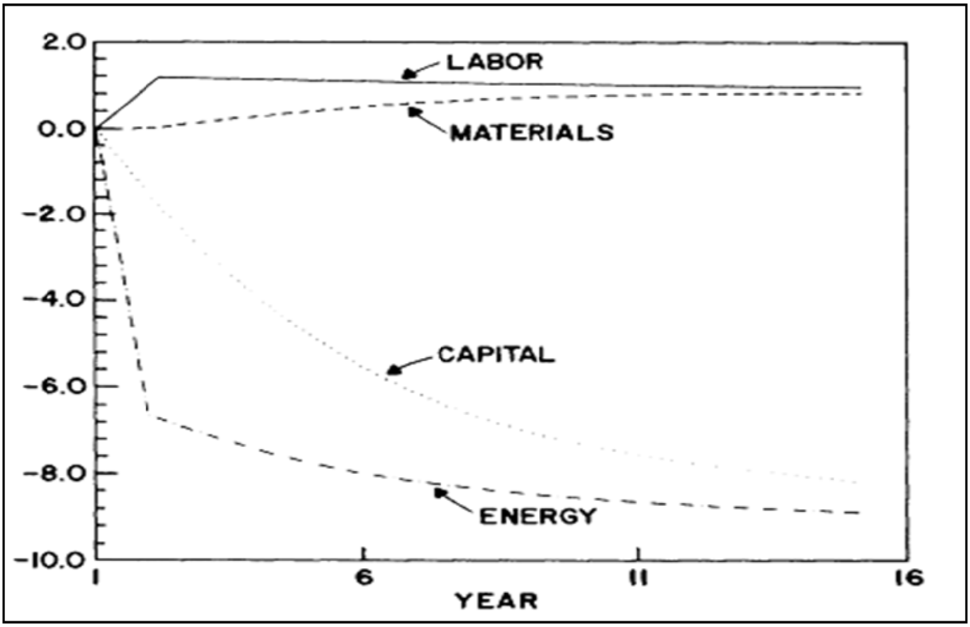
2. Theoretical Framework: Oil Price Fluctuations and Comparative Advantage

This section illustrates the theoretical link between oil price fluctuations and RCA. Currently, there is no formal economic theory that establishes the relationship between oil price fluctuations and comparative advantage. The following models are appropriate because the Ricardian and H-O theories of comparative advantage are explained by relative differences in labour productivity and the factor abundance of inputs. Differences in the sources of comparative advantage proposed by these two trade theories suggest that comparative advantage could change if there are changes in labour productivity or in the composition of capital and labour in the production of a good. Based on work by Pindyck and Rotemberg (1983), Hamilton (1988), and Lilien (1982), this section will demonstrate how changes in oil price may affect the allocation of factor endowments and input costs and hence their likely effect on comparative advantage.

The first model considered is a putty-putty model developed by Pindyck and Rotemberg (1983). Their model focuses on the impact of oil price shock on capital stock and energy use. The key features of the model are that capital and energy are highly complementary and that capital is subject to adjustment costs. However, the model assumes that any adjustment costs on labour are small. Because of adjustment costs, the capital stock moves slowly over time in response to changes in oil prices, but labour does not. Since energy and capital are highly complementary in production, energy moves slowly as well. In the long run, the capital stock adjusts to permanent differences in energy prices, and so does energy use.

The basic mechanism of the model implies that capital stock falls substantially when oil price rises. Figure: 1 shows a simulation of the effect of an unanticipated 10% increase in the price of oil. The major impact is a significant drop in the use of both capital and oil (which are complements), while labour use remains unchanged. Because of adjustment costs, capital falls gradually, while energy, a flexible factor, falls by a significant amount in the first period, and continues to fall in subsequent periods in conjunction with the drop in the use of capital. Three-fourths of the total drop in capital occurs in seven years, so that substantial net disinvestment occurs during the first two or three years. While labour use remains unchanged, a drop in capital stock may cause output to fall and could affect comparative advantage in an energy-intensive sector.

Figure: 1
Simulation of Pindyck and Rotemberg's (1983) Model



The second model is based on Hamilton's (1988) neoclassical model of unemployment. Hamilton's analysis centred on the reallocation of labour between sectors following an oil price shock. He showed that a large fluctuation in output could be generated by seemingly small disruptions in the supply of primary commodities such as oil. The principal mechanism of the business cycle explored by Hamilton is the possibility that an oil price increase will depress purchases by consumers of energy-using goods such as cars. The dollar value of such purchases may be large relative to the value of the energy they use. If labour were able to relocate smoothly from one sector to another, most of the lost output would be made up by gains in other sectors. On the other hand, if there are costs or delays associated with labour mobility, then the losses of one sector need not be regained by another, and the short-term aggregate loss can exceed the dollar value of the lost energy by a substantial margin.

In other words, a drop in the output of sector 1 may not necessarily be matched by an increase in the output of sector 2. While displaced workers from sector 1 may choose unemployment, sector 2 will not see an increase in output in the short run. Moreover, the period of unemployment is not necessarily limited by the amount of time necessary to relocate. If there is some probability of a return to better conditions, unemployed workers from sector 1 may rationally choose not to relocate, even if jobs offered in sector 2 pay a wage that exceeds their marginal utility of leisure. Correspondingly, the decline in the output of sector 1 may translate into a lower comparative advantage for sector 1, at least in the short run.

Oil price changes may also induce resource reallocation, for example from more adversely influenced sectors to those less adversely influenced, and such reallocation is costly (Lilien, 1982). According to the dispersion hypothesis by Lilien, oil price hikes lead to a reallocation of resources from energy-intensive to energy-efficient sectors. Such reallocative shocks necessitate a movement of labour out of adversely affected industries. As this reallocation progresses gradually because, for instance, workers have industry-specific skills or simply because of the time-consuming nature of job searching, a short-term decline in output results, involving considerable unemployment in the interim. To some extent, oil price hikes induce firms to relocate inputs across sectors so as to achieve optimal production levels, and this may directly or indirectly affect the comparative advantage of countries owing to the costly adjustment costs involved.

3. Methodology

3.1. Data and Variables

Estimation of the econometric model uses annual panel data for 36 RCA indices from 1990 to 2005 for 167 countries. In the calculation of RCA indices, this study makes use of data extracted from the UN trade data based on Revision 2 of the Standard International Trade Classification (SITC Rev. 2) at the two-digit level.[2]

The data from SITC Rev. 2 are aggregated from the four-digit level to the two-digit level to form 36 SITC Rev. 2 commodities. Correspondingly, 36 RCA indices are calculated and segregated into four categories based on the commodities' factor content intensities. To achieve this, this section uses Krause's (1987) factor content classification system to classify the 36 commodities into four factor content groups. The four factor content groups are natural-resource intensive, unskilled-labour intensive, technology (capital) intensive, and human-capital (labour) intensive. By having the commodities classified into these groupings, this section is able to evaluate the impacts of oil price fluctuations on countries with different factor endowments and manufacturing commodities with different factor intensities. Table: 1 shows the lists of 36 commodities used in the RCA calculations at the two-digit level grouped according to the factor content classification. In the process of aggregating the commodities from the four-digit level to the two-digit level, 20 commodities are excluded from the analysis because of overlapping (i.e. commodities appeared twice in two or more groupings), which accounts for 13% of the total commodities at the four-digit level.

---

[2] *SITC Revision 3, which was introduced in the mid 1980s, was an improvement on Revision 2 in terms of data availability. However, there has been a substantial time lag in the implementation of Revision 3 by several reporting countries, making fewer observations available for use in this study. See Athukorala, P. C. & Athukoralge, P. (2007) Multinational Enterprises in Asian Development, Edward Elgar Publishing, pp. 74–75, for further elaboration on SITC Classification.*

Table: 1
List of Manufacturing Commodities Included in RCA Calculation (by SITC 2 Classification)

Skilled-Labour Intensive
* 53 - Dyeing, tanning and colouring materials
* 55 - Essential oils and resinoids and perfume materials; toilet, polishing a
* 62 - Rubber manufactures
* 64 - Paper, paperboard and articles of paper pulp, of paper or of paperboard
* 67 - Iron and steel
* 69 - Manufactures of metals
* 76 - Telecommunications and sound-recording and reproducing apparatus and
* 78 - Road vehicles (including air-cushion vehicles)
Technology Intensive
* 51 - Organic chemicals
* 52 - Inorganic chemicals
* 54 - Medicinal and pharmaceutical products
* 56 - Fertilizers
* 57 - Plastics in primary forms
* 58 - Plastics in non-primary forms
* 59 - Chemical materials and products
* 71 - Power-generating machinery and equipment
* 72 - Machinery specialized for particular industries
* 74 - General industrial machinery and equipment
* 75 - Office machines and automatic data-processing machines
* 77 - Electrical machinery, apparatus and appliances
* 87 - Professional, scientific and controlling instruments and apparatus
* 88 - Photographic apparatus, equipment and supplies and optical goods
Unskilled-Labour Intensive
* 65 - Textile yarn, fabrics, made-up articles
* 81 - Prefabricated buildings; sanitary, plumbing, heating and lighting fixtures
* 82 - Furniture, and parts thereof; bedding, mattresses, mattress supports, cushions
* 83 - Travel goods, handbags and similar containers
* 84 - Articles of apparel and clothing accessories
* 85 – Footwear
Natural Resource Intensive
* 0 - Food and live animals
* 1 - Beverages and tobacco
* 2 - Crude materials, inedible, except fuels
* 3 - Mineral fuels, lubricants and related materials
* 4 - Animal and vegetable oils, fats and waxes
* 61 - Leather, leather manufactures
* 63 - Cork and wood manufactures (excluding furniture)
* 68 - Non-ferrous metals

For econometric estimation, this section uses variables suggested in traditional trade theory and augmented by recent literature (see, for example, Dollar, 1993, Harkness, 1978, Harrigan, 1997, and Greenaway, 1984). Owing to data limitations, several variables commonly cited as determinants of comparative advantage are excluded from this paper. These include R&D expenditure and other types of capital stock (such as human capital).

The variables are defined as follows:

Balassa's (1965) RCA is a measure of revealed export advantage and is used to calculate the relative export share of a country against the share of world exports of a particular commodity:

$$RCA_{ij} = (X_{ij} / X_{it}) / (X_{wj} / X_{wt}) \quad (1)$$

where X_{ij} and X_{wj} are the values of country *i*'s exports of product *j* and world exports of product *j*, respectively, and X_{it} and X_{wt} refer to country *i*'s total exports and world total exports. A comparative advantage is "revealed" if $RCA_{ij} > 1$. If RCA_{ij} is less than unity, the country is said to have a comparative disadvantage in the commodity/industry. In other words, RCA greater than 1 means that exports of product *j* as a share of country *i*'s exports are larger than its share of world exports.

Domestic real oil price (ROILD) is world crude oil price based on Dubai Crude, deflated with base year 2000 = 100, and is expressed in local currency using official exchange rates. The nominal oil prices and consumer price index (CPI) are taken from International Finance Statistics.

Real gross domestic product (RGDP) measures the output of final goods and services produced and incomes earned at constant US dollars. RGDP is used as a proxy for technological progress of countries. RGDP was rebased with base year 2000 = 100. The data on GDP is obtained from World Development Indicators.

Manufacturing value added (MANV) measures the contribution of the manufacturing sector to total production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources (World Development Indicators, 2009). The relative size of the manufacturing industry is a significant indicator of the state of the economy. Changes in MANV may reflect changes in the relative importance of the manufacturing sectors of countries. The series originates from World Development Indicators.

Trade openness is defined as Trade (Imports + Exports) / GDP. Countries with a higher "openness" index are expected to be more competitive owing to increased competition from increased trade and vice versa. The data set for exports and imports originates from the UN COMTRADE database.

Real FDI is the investment of foreign assets into domestic structures, equipment, and organizations. It does not include foreign investment into stock markets. The FDI variable is based on stock value that is the value of the share of capital and reserves (including retained profits) attributable to the parent enterprise plus the net indebtedness of affiliates to the parent enterprise. FDI is an important determinant of a country's comparative advantage, as shown in studies by Dunning (1993) and Driffield and Munday (2000). The series is obtained from World Development Indicators.

The real capital stock variable (KSTOCK) is measured using gross fixed capital formation (GFCF) at current market price. It is usually defined as the total value of additions to fixed assets by resident producer enterprises, *less* disposals of fixed assets during the quarter or year, *plus* additions to the value of non-produced assets (such as discoveries of mineral deposits, or land improvements). Real capital stock has been computed using the perpetual inventory method from the total GFCF values. The depreciation rate is 10%, which is based on Hall and Jones (1999). The H-O model emphasizes international differences in relative factor endowments. The capital stock measure is therefore an essential variable to capture the relative differences in factor endowments that contribute to a country's RCA. The series is obtained from World Development Indicators.

The total labour force variable (L) is based on World Bank population estimates that include the armed forces, the unemployed and first-time job seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector. Similar to capital stock, L would capture the relative differences in factor endowments among countries, as outlined by traditional trade theory. The series originates from World Development Indicators.

Primary supply of oil (OILSUPPLY) is expressed in Mtoe (million tons of oil equivalents). The oil supply variable is not the amount of oil available in the ground for extraction; it measures the amount of oil available in a country for domestic use. Countries with high oil consumption will normally have a high oil supply as well. The variable is intended to represent countries with varying oil dependencies. The series is obtained from the IEA.

The sub-region dummy variable (RDUMMY) captures the sub-region specific effects on comparative advantage. There are 19 sub-regions in the model, listed in Table: 2. The country dummy variable (CDUMMY) captures the country-specific effects on RCA. There are 167 countries in the data set. *WAR* is a dummy variable to indicate the effects of war in the Gulf region during 1990–1991 and 2003–2005 on the oil price variable. A deterministic trend variable, *YEAR* starts at 1990 and runs to 2005.

Table: 2
Sub-Regions in Regression

Caribbean	East Asia	Oceania	South East Asia
Central Asia	Middle Africa	South Europe	West Africa
Central America	North Africa	South Africa	West Asia
East Europe	North Europe	South Asia	West Europe
East Africa	Northern America	South America	

3.2. Econometric Estimation of Oil Price Fluctuations on RCA

To test the impacts of oil price fluctuations on RCA, in this section a panel regression analysis of 167 countries from 1990 to 2005 is performed. There are 36 equations to estimate; each equation represents an SITC commodity from the 36 SITC commodities listed in Table: 1. The 36 equations are divided into four groups based on Krause's (1987) classification: capital intensive, skilled-labour intensive, unskilled-labour intensive, and natural-resource intensive. Each group of equations is then estimated together as a system of SURE equations whereby equations within each group are linked through the disturbance term. One advantage of the SURE model is that it allows for more-efficient estimation if there are common shocks to the dependent. Cross-equation correlation in the disturbance term may exist because the RCA in one commodity may impact the RCA on other commodities.

For SURE estimation to be valid, cross-equation correlation in the disturbance term must exist. To test for contemporaneous covariance of the disturbances across equations such that $E(\mu_{it}, \mu_{jt})$ are nonzero, whereas the non-contemporaneous covariance $E(\mu_{it}, \mu_{j,t-k})$ all equal zero. The null hypothesis of no contemporaneous correlation ($H0: \sigma_{ij} = 0$, for $i \neq j$) can be tested by the Breusch and Pagan test statistic (λ), given as

$$\lambda = T \sum_{i=2}^{N} \sum_{j=1}^{N-1} r_{ij}^{2} \tag{2}$$

which is asymptotically distributed as chi-squared ($\chi 2$) with N (N−1)/2 degrees of freedom, and r_{ij} is the correlation coefficient of residuals estimated using SURE.

The number of equations to estimate in each SURE group differs according to the number of commodities listed in each factor content classification. Based on Table: 1Table: 1, there are 14 equations in the capital-intensive factor content group, 8 in the skilled-labour factor content group, 6 in the unskilled-labour factor content group and 8 in the natural-resource-intensive factor content group. Using these groupings, the SURE regressions are estimated in five ways. The first and second estimations look at the impact of oil price fluctuations on RCA at an aggregated level, from 1990 to 2005, using the following equations:

$$\log RCA_{jit} = \beta_0 + \beta_1 \log ROILD_{jit} + \beta_2 \log RGDP_{jit} + \beta_3 \log OPENS_{jit} + \beta_4 \log MANV_{jit} + \beta_5 \log KSTOCK_{jit} + \beta_6 \log L_{jit} + \beta_7 \log FDI_{jit} + \beta_8 \log OILSUPPLY_{jit} + WAR_{jit} + RDUMMY_{jit} + \varepsilon_{jit} \quad (3)$$

$$\log RCA_{jit} = \beta_0 + \beta_1 \log ROILD_{jit} + \beta_2 \log RGDP_{jit} + \beta_3 \log OPENS_{jit} + \beta_4 \log MANV_{jit} + \beta_5 \log KSTOCK_{ji} + \beta_6 \log L_{jit} + \beta_7 \log FDI_{jit} + \beta_8 \log OILSUPPLY_{jit} + WAR_{jit} + CDUMMY_{jit} + \varepsilon_{jit} \quad (4)$$

where

j = the equation number (1 = natural-resource intensive, 2 = unskilled-labour intensive, 3 = technology intensive, 4 = and human-capital intensive)

i = the countries (I = 1, 2,…..167)

t = the year (1 = 1990,….16 = 2005)

Equation (3) uses the sub-region dummy (RDUMMY), while Eq. (4) uses the country dummy (CDUMMY). There are 19 RDUMMY variables in Eq. (3) and 167 CDUMMY in Eq. (4). The remaining three estimations will be carried out using Eq. (4). The third estimation looks at the impacts of oil price fluctuations on RCA at two different periods, 1990–1996 and 1997–2005. The purpose of this regression is to determine whether there is any significant difference on the impacts of oil price fluctuations on RCA between these two periods. The choice of period is based on significant economic events that took place during the 16-year period covered in the study. During 1990–1996 the first Gulf war took place (1990–1992) and Asian countries experienced booming economic growth. Meanwhile, the 1997–2005 periods marked the outbreak of the Asian Financial Crisis in 1997–1998 and also the economic turmoil in several developed countries following the terrorist attacks on the US in 2001. It also coincided with the second Gulf war in 2003–2005, which caused instability in world oil markets.

The fourth and fifth estimations look at the impacts of oil price fluctuations on RCA on different types of country groupings. In the fourth SURE regression, the 167 countries will be divided into four levels of income, divided according to 2008 gross national income per capita (in US dollars), calculated using the World Bank Atlas method. The groups are: low income, US$975 or less; lower-middle income, US$976–3,855; upper-middle income, US$3,856–11,905; and high income, US$11,906 or more. Finally, in the fifth SURE regression analysis, the 167 countries will be divided into two groups: net oil exporters and net oil importers. There are 123 countries classified as net oil importers and 44 countries classified as net oil exporters. This classification is based on the

US Energy Information Administration (EIA) *International Energy Annual 2006* report. The primary reason for estimating the third and fourth regressions is to determine whether oil price fluctuations affect RCA differently in countries with different income levels, and in terms of whether countries are either net oil exporters or net oil importers.

4. Empirical Results

This section discusses the results obtained from the SURE estimations and the Breusch–Pagan test of serial independence. Results of the estimations are summarised in Table: 3. SURE estimations are based on a 10% level of significance.

4.1. Results of Breusch-Pagan Test of Serial Independence

The Breusch–Pagan tests of serial independence between the residuals for each SURE regression are reported at the bottom of Table: 3. Results show that the chi-square estimates are significant at 1% level for all set of equations. This demonstrates that the residuals within each SURE system are not independent and therefore that SURE is an appropriate technique. The Breusch–Pagan tests also suggest that each set of equations are jointly determined, which means that the RCA in one commodity impacts the RCA in another commodity within the same factor content classification system.

4.2. Results from Equation 3- All Countries in the Regression

Equation (3) uses 167 countries in the regression and takes into account the regional effects and the Gulf war impacts on oil prices by using appropriate dummy variables. In general, oil price fluctuations negatively affect RCA for more than 70% of the 36 equations estimated using Eq. (3). Specifically, Table: 3 shows that 13 of 14 equations of the oil price variable in the capital-intensive commodities group is significantly less than zero. Similarly, the oil price variable is negative and significant at the 10% level for skilled-labour commodities for 88% of the equations. For natural-resource-intensive commodities, the oil price variable is positively significant only in mineral and fuel commodities (SITC3).

GDP is positively significant for half of the 36 equations estimated, particularly with capital intensive, skilled-labour intensive, and unskilled-labour intensive commodities. Likewise, trade openness is positively related to RCA for 18 of the 36 equations estimated. The manufacturing value-added variable is significantly greater than zero for most equations, implying that the contribution of manufacturing to GDP is positively associated to a country’s comparative advantage. The FDI variable is positively significant in several E&E commodities, namely telecommunications (SITC76) and office machinery (SITC75). The results agree with previous work by Dunning (1993) and Driffield and Munday (2000) in that sectors with a higher level of foreign involvement, such as the E&E industry, tend to have higher productivity.

For factor endowment variables, the results are consistent with H-O theory prediction, at least in the case of capital intensive and skilled-labour intensive commodities. Results show that the CAPITAL variable for these commodities is consistently significantly greater than zero for most equations. This signifies the importance of technology and skilled labour in highly skill-intensive industries, as cited in Mora (2002) and Midelfart et al. (2000). For unskilled-labour commodities, the textiles commodities (SITC65, SITC84, and SITC85) have coefficient values greater than zero for the LABOUR variable. This is consistent with previous findings in the literature. For instance, Felicitas Nowak-Lehman et al. (2007) found that low labour costs improved the performance of Mexican exports. Similarly, Voon (1996) concluded that China's increased share of labour-intensive goods in the US market in 1980–1994 was largely due to the lower cost of labour in the country.

The OILSUPPLY variable is positive and significant at the 10% level for nearly half of the equations estimated, especially for capital intensive and skilled-labour intensive commodities. In contrast, OILSUPPLY negatively affected RCA for more than 50% of commodities in the unskilled-labour and natural-resource intensive groups. The effect of the WAR dummy has no significant relationship to comparative advantage, as most equations have coefficient values not significantly different from zero. This suggests that the temporary abrupt increase in oil price during the Gulf war periods did not significantly affect countries' comparative advantage.

Results in Eq. (3) suggest that oil price fluctuations adversely affect RCA for most manufacturing commodities except in oil-related industries such as SITC3. Results in factor endowment variables are consistent with predictions from the H-O model. Capital is positively related to RCA in most capital intensive and skilled-labour intensive commodities, while labour supply is positively related to RCA in the unskilled-labour and natural-resource intensive commodities.

Table: 3
SURE Estimation of Equation 3

Coefficient				Coefficient			
Domestic Real Oil Price	β<0	β =0	β >0	**Real GDP**	β<0	β =0	β >0
Capital Intensive	13	1		Capital Intensive	2	5	7
Skilled-Labour	7	1		Skilled-Labour		2	6
Unskilled-Labour	3	3		Unskilled-Labour		1	5
Natural Resource	3	4	1	Natural Resource	3	5	
Number of Coefficients	26	9	1	**Number of Coefficients**	5	13	18
Coefficient				**Coefficient**			
Trade Openness	β<0	β =0	β >0	**Manufacturing Value Added**	β<0	β =0	β >0
Capital Intensive	6	4	4	Capital Intensive			14
Skilled-Labour		3	5	Skilled-Labour			8
Unskilled-Labour			6	Unskilled-Labour			6
Natural Resource	1	4	3	Natural Resource	1		7
Number of Coefficients	7	11	18	**Number of Coefficients**	1		35
Coefficient				**Coefficient**			
Labour Supply	β<0	β =0	β >0	**Capital Stock**	β<0	β =0	β >0
Capital Intensive	11	2	1	Capital Intensive	8	4	2
Skilled-Labour	8			Skilled-Labour	4	3	1
Unskilled-Labour	1	1	4	Unskilled-Labour	5	1	
Natural Resource		2	6	Natural Resource	2	3	3
Number of Coefficients	20	5	11	**Number of Coefficients**	19	11	6
Coefficient				**Coefficient**			
Oil Supply	β<0	β =0	β >0	**FDI**	β<0	β =0	β >0
Capital Intensive		5	9	Capital Intensive	2	1	11
Skilled-Labour		2	6	Skilled-Labour	2	4	2
Unskilled-Labour	3	2	1	Unskilled-Labour		3	3
Natural Resource	5	2	1	Natural Resource	2	1	5
Number of Coefficients	8	11	17	**Number of Coefficients**	6	9	21
Coefficient				**Coefficient**			
War Dummy	β<0	β =0	β >0	**Year**	β<0	β =0	β >0
Capital Intensive	1	13		Capital Intensive	2	3	9
Skilled-Labour		8		Skilled-Labour		2	6
Unskilled-Labour	2	4		Unskilled-Labour	1		5
Natural Resource		8		Natural Resource	1	4	3
Number of Coefficients	3	33		**Number of Coefficients**	4	9	23

Breusch-Pagan test of independence's $\chi 2$ ***
Capital-Intensive: Pr = 0.0000*** ; Unskilled-Labour Intensive: Pr = 0.0000$^{***;}$
Natural Resource Intensive: Pr = 0.0000$^{***;}$ Skilled-Labour Intensive: Pr = 0.0000***

4.3. Results from Equation 4 - All Countries in the Regression

Equation (4) captures country-specific effects instead of region-specific effects by using country dummy variables in the regression. Mixed results were obtained for Eq. (4). The oil price variable does not significantly differ from zero for 20 (or 56%) of 36 equations estimated. Nevertheless, the oil price variable is negatively significant for 36% of the equations, mostly in the unskilled-labour intensive commodities. Trade openness and manufacturing value-added variable are positively significant at the 10% level for 22% and 36%, respectively, of the estimated equations.

For factor endowments variables, capital stock is positively significant in capital-intensive commodities for 9 of 14 equations and for 5 of 8 equations in skilled-labour commodities, predominantly in the E&E commodities (SITC 72 and SITC 74–78). Labour supply is positively significant for about 50% of the coefficients in the capital intensive, skilled-labour intensive, and unskilled-labour intensive commodities. For the oil supply variable, the coefficient signs differ from Eq. (3). About half of the 36 equations have coefficient values greater than zero, mainly in skilled-labour and capital intensive commodities. Surprisingly, FDI is negatively related to RCA in most capital intensive, skilled-labour and unskilled-labour intensive sectors. Technology-driven industries in SITC75, SITC76, and SITC78 in particular have negative coefficient values and are significant at the 10% level. The WAR dummy has values not significantly different from zero in most equations, similar to the findings from Eq. (3).

Overall, the estimations from Eq. (4) yield more insignificant coefficient estimates for oil price and factor endowments variables. Although there are fewer significant coefficients in Eq. (4) when compared to Eq. (3), those in Eq. (4) occur far more often than can be put down to random chance. The oil price variable has 44% significant coefficients, and 36% of these are significantly less from zero. Additionally, despite fewer significant coefficient estimates, Eq. (4) explains better the variations in RCA compared to Eq. (3), because Eq. (4) captures country-specific effects through the inclusion of country dummy variables. Country-fixed effects capture time-invariant country-specific effects that influence RCA, such as natural resources, weather, and population.

Table: 4
SURE Estimation of Equation 4

Coefficient				**Coefficient**			
Domestic Real Oil Price	β<0	β =0	β >0	**Real GDP**	β<0	β =0	β >0
Capital Intensive	3	10	1	Capital Intensive	8	5	1
Skilled-Labour	3	5		Skilled-Labour	7	1	
Unskilled-Labour	5	1		Unskilled-Labour	4	2	
Natural Resource	2	4	2	Natural Resource	1	6	1
Number of Coefficients	13	20	3	**Number of Coefficients**	20	14	2
Coefficient				**Coefficient**			
Trade Openness	β<0	β =0	β >0	**Manufacturing Value Added**	β<0	β =0	β >0
Capital Intensive	5	6	3	Capital Intensive	1	8	5
Skilled-Labour	5	3		Skilled-Labour		5	3
Unskilled-Labour	3	2	1	Unskilled-Labour		4	2
Natural Resource		4	4	Natural Resource		5	3
Number of Coefficients	13	15	8	**Number of Coefficients**	1	22	13
Coefficient				**Coefficient**			
Labour Supply	β<0	β =0	β >0	**Capital Stock**	β<0	β =0	β >0
Capital Intensive	1	6	7	Capital Intensive	1	4	9
Skilled-Labour	1	3	4	Skilled-Labour		3	5
Unskilled-Labour	1	2	3	Unskilled-Labour		3	3
Natural Resource		6	2	Natural Resource	2	5	1
Number of Coefficients	3	17	16	**Number of Coefficients**	3	15	18
Coefficient				**Coefficient**			
Oil Supply	β<0	β =0	β >0	**FDI**	β<0	β =0	β >0
Capital Intensive	1	6	7	Capital Intensive	10	3	1
Skilled-Labour	1	3	4	Skilled-Labour	4	4	
Unskilled-Labour		4	2	Unskilled-Labour	3	1	2
Natural Resource	1	3	4	Natural Resource	3	3	2
Number of Coefficients	3	16	17	**Number of Coefficients**	20	11	5
Coefficient				**Coefficient**			
War Dummy	β<0	β =0	β >0	**Year**	β<0	β =0	β >0
Capital Intensive	1	11	2	Capital Intensive	3	10	1
Skilled-Labour		4	4	Skilled-Labour	2	4	2
Unskilled-Labour		4	2	Unskilled-Labour	2	4	
Natural Resource	1	7		Natural Resource		7	1
Number of Coefficients	2	26	8	**Number of Coefficients**	7	25	4

Breusch-Pagan test of independence's χ2 ***
Capital-Intensive: Pr = 0.0000***; Skilled-Labour Intensive: Pr = 0.0000***
Unskilled-Labour Intensive: Pr = 0.0000***; Natural Resource Intensive: Pr = 0.0000***

Note: Breusch-Pagan χ2 statistic is under the null hypothesis that the equations are not related. Symbol [***] denotes statistical significance at the 1% level.

4.4. Results of Estimations for 1990-1996 and 1997-2005

Table: 5 shows SURE estimates for two periods: 1990–1996 and 1997–2005. For both periods, country-specific effects are incorporated into the regressions. The results demonstrate that the oil price variable significantly differs from zero only for 28% of the equations in 1990–1996 compared to 56% in 1997–2005. From 1997 to 2005, crude oil price increased by 233% (from US$15 to US$55 per barrel). There were also more variations in oil price movements in the second period, brought about by the economic turmoil in the Asian economies and the instability in the Gulf region later in the same period. The large increase in price and greater variations in oil price may help to explain the higher number of negatively significant coefficients of oil price variable during the 1997–2005 periods. This also shows that manufacturing commodities' RCAs are more prone to changes during periods of economic uncertainty and when there are large and immediate increases in oil prices.

Table: 5
Estimation for Two Periods – (1990-1996 & 1997-2005)

ESTIMATION OF EQUATION 1990-1996				**ESTIMATION OF EQUATION 1997-2005**			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$	**Domestic Real Oil Price**	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive	2	9	3	Capital Intensive	6	6	2
Skilled-Labour		8		Skilled-Labour	3	4	1
Unskilled-Labour	1	4	1	Unskilled-Labour	4	2	
Natural Resource	3	5		Natural Resource	2	4	2
Number of Coefficients	6	26	4	**Number of Coefficients**	15	16	5
Breusch-Pagan test of independence's $\chi 2$ *** Capital-Intensive: Pr = 0.0000*** Skilled-Labour Intensive: Pr = 0.0000*** Unskilled-Labour Intensive: Pr = 0.0000*** Natural Resource Intensive: Pr = 0.0000***				**Breusch-Pagan test of independence's $\chi 2$ ***** Capital-Intensive: Pr = 0.0000*** Skilled-Labour Intensive: Pr = 0.0000*** Unskilled-Labour Intensive: Pr = 0.0000*** Natural Resource Intensive: Pr = 0.0000***			

4.5. Results of Estimation of Countries with Differing Levels of Income

Using Eq. 4, Table: 6 shows summary results of SURE estimations when sample countries are grouped into four levels of income. To reduce the table size, only the domestic oil price variable results for each income level are shown. Overall, oil price fluctuations negatively affect RCA for at least 16% of the commodities in each income group, with upper-middle income economies recording the highest number of significant negative oil price coefficients, equivalent to 31% of the total estimated equations. Interestingly, the oil price variable is statistically insignificant in both capital intensive and skilled-labour intensive commodities in the high-income economies. In contrast, oil price is negatively significant for other income groups, between 18% and 27% for the same commodities groups. The difference in results could be due to energy-saving production techniques employed by high-income economies compared to the less energy-efficient methods of production used by middle- and low-income countries. For unskilled-labour commodities, results for high income and upper-middle income countries are comparable. Both groups have oil price variables that are significantly less than zero for at least 66% of the commodities estimated.

Results from the SURE estimations suggest that the effect of oil price fluctuations on RCA is minimal for high income and lower-middle income economies. On the other hand, oil price fluctuations negatively affect RCA for around 30% of commodities in upper-middle income and low income economies. This outcome may lend support to the finding by the IEA (2004) that developing countries are more prone to oil price hikes compared to developed (high income) countries because of developing countries' high oil intensity and less energy-efficient production methods.

Table: 6
Estimation for Various Income Levels

High Income Economies (41 Countries)			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive		14	
Skilled-Labour		8	
Unskilled-Labour	4	2	
Natural Resource	2	6	
Number of Coefficients	6	30	

Breusch-Pagan test of independence's $\chi2$ *
Capital-Intensive: Pr = 0.0000*
Skilled-Labour Intensive: Pr = 0.0000*
Unskilled-Labour Intensive: Pr = 0.0000*
Natural Resource Intensive: Pr = 0.0000*

Upper Middle Income Economies (35 countries)			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive	4	10	
Skilled-Labour	1	7	
Unskilled-Labour	5	1	
Natural Resource	1	7	
Number of Coefficients	11	25	

Breusch-Pagan test of independence's $\chi2$ *
Capital-Intensive: Pr = 0.0000*
Skilled-Labour Intensive: Pr = 0.0000*
Unskilled-Labour Intensive: Pr = 0.0000*
Natural Resource Intensive: Pr = 0.0000*

Lower Middle Income Economies (47 countries)			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive	3	11	
Skilled-Labour	1	7	
Unskilled-Labour	1	5	
Natural Resource	1	7	
Number of Coefficients	6	30	

Breusch-Pagan test of independence's $\chi2$ *
Capital-Intensive: Pr = 0.0000*
Skilled-Labour Intensive: Pr = 0.0000*
Unskilled-Labour Intensive: Pr = 0.0000*
Natural Resource Intensive: Pr = 0.0000*

Low Income Economies (44 countries)			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive	3	11	
Skilled-Labour	3	5	
Unskilled-Labour	2	4	
Natural Resource	2	5	1
Number of Coefficients	10	25	1

Breusch-Pagan test of independence's $\chi2$ *
Capital-Intensive: Pr = 0.0000*
Skilled-Labour Intensive: Pr = 0.0000*
Unskilled-Labour Intensive: Pr = 0.0000*
Natural Resource Intensive: Pr = 0.0000*

4.6. Results for Net Oil-Exporting and Net Oil-Importing Countries

Table: 7 summarizes the results of SURE regression for the oil price variable estimated for countries classified as net oil exporters and net oil importers. From 167 sample countries, 123 are net oil-importing, while 44 are net oil-exporting. Of the 123 net oil-importing countries, 31 (25%) are high-income economies. Results from the regression show that oil price fluctuations negatively affect RCA for 58% of the commodities among net oil-exporting countries compared to 31% among net oil-importing countries. Given that current production techniques used by the former countries (which primarily consist of upper-middle income and low income economies) are less energy-efficient than those of high income economies, higher oil prices may cause energy-intensive production costs in oil-exporting countries to increase relatively more than in oil-importing countries (especially among high income countries). Consequently, net oil importers' comparative advantage may be less adversely affected by oil price fluctuations than that of oil-exporting countries. Alternatively, especially in Middle East countries, higher oil prices may simply lead to neglect of the tradable sectors, giving rise to the "Dutch disease" among oil-exporting countries.

Table: 7
Estimation for Net Oil-Exporting and Net Oil-Importing Countries

Net Oil Exporter				Net Oil Importer			
Domestic Real Oil Price	$\beta<0$	$\beta=0$	$\beta>0$	**Domestic Real Oil Price**	$\beta<0$	$\beta=0$	$\beta>0$
Capital Intensive	7	7		Capital Intensive	2	11	1
Skilled-Labour	6	2		Skilled-Labour		8	
Unskilled-Labour	6			Unskilled-Labour	1	4	1
Natural Resource	2	5	1	Natural Resource	8		
Number of Coefficients	21	14	1	**Number of Coefficients**	11	23	2
Breusch-Pagan test of independence's $\chi2$ ***				**Breusch-Pagan test of independence's $\chi2$ *****			
Capital-Intensive: Pr = 0.0000***				Capital-Intensive: Pr = 0.0000***			
Skilled-Labour Intensive: Pr = 0.0000***				Skilled-Labour Intensive: Pr = 0.0000***			
Unskilled-Labour Intensive: Pr = 0.0000***				Unskilled-Labour Intensive: Pr = 0.0000***			
Natural Resource Intensive: Pr = 0.0000***				Natural Resource Intensive: Pr = 0.0000***			

5. Conclusion

This paper has estimated the relationship between crude oil price movements and RCA for a panel of 167 countries using an unrestricted SURE method over the period 1990–2005. To test the impact of oil price fluctuations on RCA, 36 RCA indices were calculated from 36 manufacturing exports commodities with SITC two-digit level data using Balassa's (1965) approach. These 36 RCA indices were divided into four groups based on Krause's (1987) factor content commodity classification system. Using Krause's specification, 14 (RCA) commodities were located in the capital-intensive group, 8 (RCA) commodities in the skilled-labour group, 6 (RCA) commodities in the unskilled-labour group, and 8 (RCA) commodities in the natural-resource-intensive group.

The SURE estimations were carried out in five ways. The first and second estimations were performed using two different sets of equations, with each equation distinctively differentiated by using specific dummy variables. The third SURE regression looked at the impact of oil price fluctuations on RCA over the periods 1990–1996 and 1997–2005. The fourth regression was estimated according to countries' levels of income, while the fifth estimation was based on whether countries were either net oil exporters or net oil importers. Findings for these estimations are summarised as follows. First, when estimated using a region-specific dummy, the oil price variable was found to be significantly less than zero for 70% (or 26 of 36) of the RCA commodities. Second, when using a country-specific dummy, oil price fluctuations negatively affect only 36% (or 13 of 36) of RCA commodities. Results from these two estimations suggest the presence of omitted variable bias when using a region-specific dummy. Subsequently, the third, fourth, and fifth estimations used a country-specific dummy instead.

For the third regression, oil price fluctuations significantly affected around 58% of RCA commodities in 1997–2005 compared to 28% of RCA commodities in 1990–1996. The impact of oil price fluctuations on RCA was greater in 1997–2005 than in 1990–1996 because there were more adverse economic incidents recorded in this period, which led to more frequent and abrupt oil price movements. In the fourth estimation, oil price fluctuations were found to be negatively related to RCA for at least 16% of the commodities in all income groups, with upper-middle income economies recording the highest number of significant negative oil price coefficients, equivalent to 31% of the total estimated equations. Given the dominant role of the manufacturing sector among the upper-middle income countries when compared to other income groups, fluctuations in oil prices are therefore expected to affect this group more than the others.

Finally, oil price fluctuations negatively affect RCA by as much as 58% of the commodities among net oil-exporting countries. In contrast, net oil-importing countries have negatively significant oil price variables for 31% of the commodities estimated. Although net oil-exporting countries are expected to benefit from higher oil prices, findings from this paper may indicate that the Dutch disease phenomenon is experienced among the oil-exporting countries. From 1990 to 2005, real oil price increased by 83%. For oil-exporting countries, increases in oil price caused real exchange rates to appreciate. This led to loss of competitiveness in the tradable sector (in this case the manufacturing sector) as resources were shifted towards the booming (in this case the oil) sector.

References

Balassa, B. (1965), "Trade Liberalization and Revealed Comparative Advantage", *The Manchester School of Economic and Social Studies, 33*(2), 99-124.

Balassa, B. A. (1977), *"Revealed" Comparative Advantage*: Johns Hopkins University, Dept. of Political Economy.

Berument, M.H., N.B. Ceylan & N. Dogan (2005), "The Impact of Oil Price Shocks on the Economic Growth of Selected MENA Countries", *The Energy Journal, 31*(1).

Bhagwati, J. (1998), *The Global Age: From Skeptical South to a Fearful North in A Stream of Windows–Unsettling Reflections on Trade, Immigration, and Democracy:* Cambridge, Massachusetts, The MIT Press.

Burbridge, J. & A. Harrison (1984), "Testing For the Effects of Oil--Price Rises Using Vector Autoregressions", *International Economic Review, 25*(2).

Driffield, N. & M. Munday (2000), "Industrial Performance, Agglomeration, and Foreign Manufacturing Investment in the UK", *Journal of International Business Studies, 31*(1).

Dunning, J.H. (1993), *Multinational enterprises and the global economy*: Addison-Wesley Reading, Mass.

Felicitas Nowak-Lehmann, D., V. Sebastian & M.Z. Immaculada (2007), *Competitiveness - A Comparison of China and Mexico*: CESifo GmbH.

Gisser, M. & T.H. Goodwin (1986), "Crude Oil and the Macroeconomy: Tests of Some Popular Notions", *Journal of Money, Credit & Banking, 18*(1), 95-103.

Hall, R.E. & C.I. Jones (1999), "Why Do Some Countries Produce So Much More Output per Worker than Others?*". *Quarterly Journal of Economics, 114*(1), 83-116.

Hamilton, J.D. (1983), "Oil and the Macroeconomy since World War II", *Journal of Political Economy, 91*(2), 248.

Hamilton, J.D. (1988), "A Neoclassical Model of Unemployment and the Business Cycle", *The Journal of Political Economy, 96*(3), 593-617.

Hunt, B., P. Isard & D. Laxton (2001), "The Macroeconomic Effects of Higher Oil Prices", *IMF Working Paper,* (Vol. WP/01/14).

International Energy Agency (2004), *Analysis of the Impact of High Oil Prices on the Global Economy*.

Krause, L.B. (1987), "The Structure of Trade in Manufactured Goods in the East and Southeast Asian Region: *Trade and Structural Change in Pacific Asia*.

Lee, K., S. Ni & R.A. Ratti (1995), "Oil shocks and the macroeconomy: The role of price variability", *The Energy Journal, 16*(4), 39-56.

Lilien, D.M. (1982), "Sectoral Shifts and Cyclical Unemployment", *Journal of Political Economy, 90*(4), 777-793.

Mork, K. A. (1989), "Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results", *Journal of Political Economy, 97*(3).

Rasche, R.H., & J.A. Tatom (1977), "Energy Resources and Potential GNP", *Federal Reserve Bank of St. Louis Review, 59*(6), 10-24.

Rasche, R.H., & J.A. Tatom (1981), "Energy Price Shocks, Aggregate Supply and Monetary Policy: The Theory and International Evidence", *Carnegie-Rochester Conference Series on Public Policy, 14*, 9-93.

Pindyck, R.S. & J.J. Rotemberg (1983), "Dynamic Factor Demands and the Effects of Energy Price Shocks", *The American Economic Review, 73*(5), 1066-1079.

Voon, T., Centre for Asian Pacific, S. & Faculty of Social, S. (1996), *Export Competitiveness of China and ASEAN in the US Market*: Faculty of Social Sciences, Lingnan College Hong Kong.

Zellner, A. (1962), "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias", *Journal of the American Statistical Association, 57*(298), 348-368.