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The Economic Impact of Oil Price Shocks on Emerging Markets

SUBMITTED TO

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FOR

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Abstract

Recent spikes in oil prices have thrown light on how economic activity in emerging markets may be impacted by oil price shocks. This paper conducts an empirical analysis of the effect of oil price shocks on emerging markets. It tests for the existence of an asymmetrical relationship between oil prices and economic activity using a model developed by James Hamilton. It also assesses the impact of structural shocks to the real price of oil on output as proposed by Lutz Kilian. While our models find no consistent pattern within emerging markets, they do suggest that oil price shocks have a greater significance in 2000-2009 than in the full sample of 1974-2009. We also find that emerging economies are impacted by changes in oil specific demand but unaffected by changes in aggregate demand for industrial commodities.

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1. Introduction

In the last four years, oil prices has gone from $60 in March 2007 to $145 in July 2008, fallen back to $40 in March 2009, and risen once again to $110 in April 2011[1]. The first increase preceded the global recession, and the second may derail the recent recovery. This relationship between oil prices and the macroeconomy has been observed for all but one recession since 1950(Hamilton 1983). Changes in oil prices can affect the economy through multiple channels. These include a rise in the costs of production, a rise in inflation, uncertainty regarding investment, or a transfer of wealth from oil exporting countries to oil exporting countries.

Researchers have applied various linear and nonlinear methodologies to capture the magnitude and direction of the oil price-macroeconomy relationship but have mostly limited their study to advanced economies. From 2008 onwards, annual oil consumption in emerging markets has exceeded annual oil consumption in the United States[2]. The dual issues of increasing oil demand from developing countries along with depletion in oil supplies make the study of oil prices and emerging economies highly pertinent. This paper extends the approaches pioneered by James Hamilton and Lutz Kilian in the study of oil prices and their impact on output to emerging markets. The paper is organized as follows. Section 2 presents a review of the existing literature on the oil price-macroeconomy relationship. Section 3 presents the main features and trends of the oil price market and emerging market economies. Section 4 and 5 cover the empirical analysis and Section 6 provides some concluding remarks.

2. Literature Review

The study of oil shocks and the macroeconomy was pioneered by Hamilton during the 1980s, a period that was preceded by large increases in oil prices. In his study,

[1] Source: U.S. Energy Information Administration
[2] Emerging markets consists of Brazil, India, China, and the Middle East. Source: U.S. Energy Information Administration

Hamilton found that most recessions in the US prior to 1972 were preceded by increases in oil prices by about ¾ of a year. He presented three hypotheses as explanations for this phenomenon – i) The correlations represent historical coincidence, ii) Correlations result from existence of endogenous explanatory variable that affects both series, and iii) At least some of the recessions in the US are caused by exogenous increases in oil shocks. His model rejected the first two hypotheses but was unable to reject the third statement. Hamilton found that 1948 – 1980 was characterized by a statistically significant relationship between oil prices and real US Gross National Product.

Mork (1989) extended Hamilton's analysis to the 1980s, a period characterized by a collapse in oil prices, and found that the relationship between oil prices and output was considerably weaker. However, if positive and negative movements in oil prices were treated as separate variables, the former continued to be statistically significant. This suggested that oil prices and output are characterized by an asymmetric relationship where oil price decreases do not have an expansionary effect on economic activity, and may even have a contractionary effect. Hooker (1996) also found that the relationship between output and oil prices had weakened in the 1980s. His results showed that oil prices failed to Granger-cause most economic variables, including GDP, when looking at the period from 1973 – 1995. Even after correcting for the asymmetric relationship between oil prices and output, the former failed to Granger-cause the latter.

Hamilton (1996) responded to this research by accepting its findings but disagreeing with Hooker's and Mork's treatment of shocks to oil prices. He argued that since most of oil price increases since 1986 had followed even larger decreases, looking at the quarterly change in oil prices would imply more oil price volatility then there actually was. Rather, he believed that consumers would be affected by yearly changes and thus oil price shocks should compare the current price to the price over the previous year. He called this the net oil price increase (NOPI), a measure which is extensively used in current research in energy economics. Using the NOPI, Hamilton found that the relationship between GDP growth and oil prices was not statistically significant during the smaller sample period of 1973 – 1994 but it was statistically significant during the full sample period from 1948 – 1994. It should be noted that despite the statistical insignificance of the former relationship, the individual coefficient with the greatest significance was the one relating GDP growth to the net oil price increase four quarters earlier. This result validates Hamilton's preference for yearly over quarterly changes in oil prices.

Mork's observations on the asymmetrical relationship between oil prices and output were followed by several studies that tried to explain this puzzle. Hamilton proposed that the asymmetry existed due to uncertainty in the price and supply of energy which caused individuals and firms to postpone their investment decisions. This mechanism implied that an oil price decrease would not have the mirror effect of an oil price increase. Ferderer (1996) expanded on Hamilton's mechanism and found that oil price shocks affected economic activity through uncertainty channels and sectoral shocks. These mechanisms suggest that oil price changes affect the prices of goods in energy-intensive industries, such as consumer durables, by changing cost structures which further affects the demand for these goods. The reduction in demand due to uncertainty in oil prices creates a surplus of labor and capital in energy-intensive sectors. Since it is costly to shift specialized labor and capital between sectors, changes in oil prices would cause unemployment in the negatively affected sectors. These channels had been previously examined by Hamilton (1983; 1996) and Bernanke (1983) and were accepted as one of explanations for the persistence in oil shocks.

The 2000 boom in oil prices and the 2003 Iraq War set the stage for further discussion on the relationship between oil prices and output. Barsky and Kilian (2004) claimed that recent movements in oil prices could not be treated as exogenous shocks and that earlier models suffered from endogeneity. They challenged the uncertainty and sectoral shifts channel on the grounds that the drops in purchases of consumer durables after the shocks of 1974, 1979, and 1990 were rather small by historical standards and that the decline began before the event associated with the oil shock. This evidence weakened the argument that oil prices affected economic activity through a reduction in the demand for durables. Barsky and Kilian further went on to say that events in the Middle East did not play as prominent a role in determining oil prices as had been previously accepted. They claimed that political events in the Middle East resulted in an increase in the precautionary demand for oil. This implied that events such as war would results in shifts of the demand curve rather than the supply curve. They dispelled the supply shocks model by showing that supply cuts of similar magnitude had very different effects on oil prices. Rather, the true effect of a supply shock would depend on the response of other suppliers and the overall macroeconomy. They highlighted the importance of expectations regarding oil supply rather than actual supply itself.

Kilian (2009) proposed that movement in crude oil prices could be decomposed into the following three components – crude oil supply shocks; shocks to the global demand for all industrial commodities; and demand shocks specific to the global crude oil market. He tested this hypothesis with the help of a structural vector auto regression of the global crude oil market which consisted of the real price of oil, the percent change in global crude oil production, and an index of real economic activity. His results showed that shocks to aggregate demand had persistent and highly significant effects on economic activity and oil prices while precautionary demand shocks caused an immediate and persistent rise in oil prices. Interestingly, his results showed that supply shocks only resulted in a small increase in the real price of oil. These results suggest that the large spikes in oil prices during the 1970s and 1990s were driven by the effect of political turmoil in the Middle East on precautionary demand rather than supply. Hamilton (2009), however, challenges Kilian's assertion that precautionary demand supersedes supply shocks and backs it up by showing that U.S. inventories of crude oil and petroleum products (measured as percentage of global production) were going down, not up, during the sharpest movements in oil prices. If precautionary demand shocks have a significant effect on oil prices, one would expect that inventory levels would rise following an event expected to disrupt oil supply. Hamilton's finding suggests that there may be more to oil price shocks, whether they occur due to shifts in supply or precautionary demand, which will only be revealed with future movements in oil prices.

The above debate does reveal one interesting conclusion that is shared by both authors- the recent oil price shock of 2007-2008 is attributed to increased economic activity combined with stagnating world production. The late 2000s were a period characterized by high growth, where world GDP grew by 9.4% in 2004 and 2005 and by 10.1% in 2006 and 2007(Hamilton 2009). During this period, the share of emerging markets in world GDP also grew significantly. This increase was accompanied by a rise in their energy consumption which would increase their impact on world energy prices significantly. China, alone, had become the third biggest importer of petroleum by 2007. As the energy consumption of emerging markets continues to increase, the recent oil shock provides an opportunity to study the impact of movements in oil prices on economic activity in these markets.

Previous studies on the impact of oil price shocks on economic activity have primarily focused on the US and other developed countries such as the UK, France, Germany, Canada, and Italy. Hamilton (1983; 1996), Kilian (2004; 2008), Hooker (1996), Mork (1989), and Ghosh, Varvares, and Morley (2009) each provide empirical evidence that increases in oil prices have a significant effect on the US economy, even if they differ on the magnitude and pattern of the effects. Other researches expanded this research to the G-7 countries and members of the OECD. Mork (1994) studied the economic response to oil price increases and decreases in seven OECD countries and found that correlations with oil price increases and output were negative and significant for most countries whereas correlations with oil price decreases were negative but only significant for the US and Canada. Rodriguez and Sanchez (2009) apply a linear VAR as well as three nonlinear approaches to the US, Germany, France, Italy, and the UK and find evidence of nonlinear effects of oil price on real economic activity and inflation. Rodriguez (2008) assesses the effect of oil price shocks on the output of the main manufacturing industries in six OECD countries and finds that while similarity is maintained in the group for certain industries such as machinery and equipment, it does not exist for industries such as wood and wood products.

There are a small number of studies that have attempted to extend this research to developing countries, however, they either focus on a relatively small number of countries or do not take recent data into account. Balassa (1985) studies the differences in economic growth in 43 developing countries following the 1973 oil shock. He finds that policy choices account for a large proportion of the intercountry differences in GNP growth rates during the period following the oil shock. Zilberfarb and Adams (1981) focus on the income elasticity of energy consumption for developing countries and test the stability of the relationship between energy consumption and GDP. They find that the income elasticity is about 1.35 and that the relationship has been stable over time period extending from 1970 – 1976. Other research in the area has focused on specific regions or countries. Cunado and Perez de Gracia's (2005) study of a few Asian countries (Japan, Singapore, South Korea, Malaysia, Thailand, and the Philippines) reveals that oil price shocks Granger-cause economic growth rates in Japan, South Korea, and Thailand. They also find that results differ significantly if oil prices are modified by multiplying them with country-specific exchange rates. Other studies include an examination of how oil price shocks affected the output growth of Turkey (Schubert and Turnovsky 2011) and Middle Eastern and North African countries (Berument, Ceylan, and Dogan 2010).

3. Data

A survey of the existing oil shock literature reveals a variety of data series and methodologies that are employed to test for the impact of oil price shocks on economic activity. Our full list of data series can be found in the Appendix in Table 1. Most researchers use one of the following two indices as a measure of oil prices - the $US price of oil as measured by the West Texas Intermediate benchmark and the £UK price of oil as measured by Brent benchmark. The nominal price of oil may then be deflated using relevant consumer price indices or country specific exchange rates. The most commonly used proxy for economic activity is gross domestic product at the national level. Alternative series include industrial production, output by industry/sector, and non-farm business output.

3.1. Identifying the Real Price of Oil

This paper uses the $US refiner acquisition cost for crude oil obtained from the US Department of Energy (DOE) as a measure of oil prices and deflates it using the US CPI (Consumer Price Index) to obtain the real price of oil. This series has been used previously by Hamilton (1996), Hooker (1996), and Kilian (2009) in their studies of the impact of oil shocks on economic activity. World oil production data is also sourced from the US DOE.

3.1.1. Trends in the Real Price of Oil

The volatility of oil prices in the recent decade is reminiscent of the oil shocks during the 1970s and early 1980s. Although the recent oil shocks match those of the 1970s in real terms, they are significantly larger in nominal prices. Figure 1 illustrates the movements in the nominal and the real price of oil while Figure 2 illustrates trends in world oil production.

During the early to mid-1900s, real oil prices were largely stagnant and hovered around $20/barrel. The notable events during this period included the Suez crisis in November 1956, which caused a drop of 10.1% in crude oil production. The 1970s were marked by dramatic increases in oil prices which were driven by shortfalls in supply due to the OPEC embargo placed on Western countries in 1967 followed by the Arab-Israel War in 1973 and the Iranian Revolution in 1978. These events caused drops of 7.8% and 8.9% in world crude oil production respectively. Prices rose again in 1980 as a result of the Iran-Iraq war which caused production to fall by 7.2%. The high fuel prices of the 1970s slowed economic activity in many countries and led others to conserve energy. This led to an oversupply of oil during the 1980s, which caused a significant decline in world oil prices. The next oil shock came in 1990 due to the Persian Gulf War which caused production to fall by 8.8%. The 1997 crisis in East Asia reduced demand for crude oil which led to a temporary decline in prices, however, the decline was soon reversed in the 2000s.

The oil price increases in the past decade differed from earlier movements in that they were not driven by supply disruptions. Rather they were driven by a variety of factors which include rising demand from developing countries and slowdowns in oil supply growth. The slowdown in oil supply growth began when oil production surpassed new discoveries. The expected future decrease in oil supplies is the fundamental long-term cause behind rising oil prices. Speculation on oil price futures also played a significant role in driving nominal oil prices well above $100 in 2007 and 2008. The financial crisis and the ensuing recession caused oil prices to fall from their record high; however, the past few months have seen a surge in oil prices due to the tensions in the Middle East. It is unclear how oil prices may move as the Middle Eastern situation remains tense and concerns about long term oil supply depletion become larger.

3.2. Identifying Economic Growth in Emerging Markets

This paper employs two distinct series to measure the level of economic activity. On a national level, we use the real gross domestic product (GDP) obtained at a quarterly frequency from the IMF International Financial Statistics (IFS) database. To identify countries in emerging markets, we use the countries identified as 'emerging' by the S&P Emerging Markets Index. We also limit our study to countries that have quarterly real GDP data available for a minimum of 48 quarters. This ensures that we can capture the effect of the recent oil price shocks and that our regressions have sufficient degrees of freedom. The full list of countries and data availability for each country can be found in Table 2. At the global level, we use the demand for industrial commodities in world markets as measured by the Baltic Dry Exchange Index, which is a composite series of world ocean freight rates. We deflate the index using US CPI. The nominal and real Index are depicted in Figure 3.

The positive correlation between ocean freight rates and economic activity has been previously documented by Isserlis(1938), Tinbergen(1959), and Stopford(1997). Kilian (2009) proposes that demand for transport services is mostly driven by changes in global economic activity. Changes in freight rates reflect the changes in demand for transport services and thereby changes in the level of world economic activity. While the correlation may not be perfect, it serves as a proxy for demand for industrial commodities, which are mostly shipped by sea. Alternatives like industrial production and gross domestic product are not available at such a high frequency and are not available for all countries.

3.2.1. Summary Statistics for Real GDP Growth in Emerging Markets

Before we examine the oil price-macroeconomy relationship, it may be useful to survey trends in economic activity in emerging markets. Table 3 provides statistics on economic growth, sectoral composition, and net imports of oil in emerging economies.

Economic growth in emerging markets has been well above world averages in the last decade. From 1992 to 2001, emerging markets grew at 3.8% annually compared to a 2.8% annual growth in advanced economies. The gap widened in the 2000s and reached its maximum in 2007 at 5.5 percentage points. The divergence in growth rates became particularly apparent during the credit crisis in 2009 when advanced economies contracted by 3.2% while emerging markets grew by 2.4%. The World Bank's forecasts indicate that the gap will continue to persist through 2015 as emerging markets are forecast to grow at 6.7% while advanced economies are forecast to grow at 2.3%.

A look at sectoral composition reveals that emerging markets are more dependent on agriculture than the rest of the world. While the world average for contribution of agriculture to GDP is 5.7%, most emerging economies earn more than 7% of gross domestic product from agriculture, with some relying on it for more than 10% of output. The breakup between industry and services for the world is 30.7% and 63.6% respectively. This is not too different from emerging economies which have an average of 33% and 59% respectively.

The growing demand for energy in emerging markets has been identified as one of the leading causes behind the run up in prices in 2007 and 2008. Most emerging economies are net importers of oil with the exception of Malaysia, Argentina, Brazil, Colombia, and Russia. While oil supplies from South America still look promising, Malaysia's net exporter position has been diminishing over the past few years. The growing need for oil in emerging economies becomes apparent when one considers that oil consumption in emerging markets has exceeded oil consumption in the United States since 2008.

4. Methodology

Previous studies on the impact of oil shocks on emerging markets have employed many different methods to model oil price shocks. The important debates on methodology are centered on two issues – asymmetry in the relationship between oil prices and economic activity, and the exogenous nature of oil shocks. Some researchers have identified an asymmetrical relationship between oil prices and economic activity and thus define oil price shocks as positive movements in oil prices (Hooker 1996; Hamilton 1996). Others have treated oil price increases and decreases as separate variables (Mork 1989). Yet others do not address this issue and treat all movements in oil prices similarly (Jimenez-Rodriguez 2008).

The second debate concerns the exogeneity of oil price shocks. While oil shocks prior to 1980 were directly linked to political events in the Middle East, recent movements in oil prices in recent years have been significantly affected by domestic economic activity, foreign economic activity, interest rates, and core inflation. Hamilton(1996), Hooker(1996), and Mork(1989) estimate regressions with GDP growth as the dependent variable and lagged values of GDP growth and oil price shock measures as explanatory variables. Barsky and Kilian(2004) were among the first to draw attention to the possibility of endogeneity in the relationship between oil prices and economic activity. To correct for this endogeneity, Kilian(2009) proposed that changes in oil prices could be decomposed into three components – precautionary demand, supply, and aggregate demand. He carried out this decomposition through a VAR model consisting of real oil prices, world oil production, and global economic activity. This model has gained favor in recent years and has been modified to include the effect of interest rates, inflation, and foreign trade (Ghosh, Varvares, and Morley 2009).

4.1. Modeling Net Oil Price Increases

This paper will employ two separate models to test if oil prices have a significant effect on economic activity in emerging markets. The first model is similar to the one employed by Hamilton (1996). It allows for asymmetry in the relationship between oil prices and economic activity and treats oil shocks as exogenous. For each country, we estimate the following regression:

$$\Delta \mathrm{y_t} = \alpha_0 + \sum_{i=1}^{4} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{4} \alpha_{2i} o_{t-i}^{\#} \qquad (1)$$

In equation (1), y_t is log levels of real GDP and $o^{\#}$is the net oil price increase (NOPI) as defined by Hamilton (1996). As specified by Hamilton, we include four lags each of real GDP growth and net oil price increases. The NOPI is computed as shown below:

$$NOPI = \max[0, (ln(oil_t) - ln(max(oil_{t-1}, \ldots, oil_{t-12})))] \qquad (2)$$

The NOPI compares the real price of oil each quarter with the maximum value observed during the preceding twelve quarters. If the value for the current quarter exceeds the previous three years' maximum, the percentage change over the previous maximum is plotted. If the value does not exceed the previous three years' maximum, the series is defined as zero for that quarter. The historical evolution of oil price shocks as implied by the NOPI is plotted in Figure 4.

By regressing country level GDP on seasonal dummies, we find strong evidence of seasonal trends in the data. To correct for this, we modify Hamilton's model to include seasonal dummies. After adjusting for seasonal trends, the model has the following specification:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i}\Delta y_{t-i} + \sum_{i=1}^{k} \alpha_{2i} o_{t-i}^{\#} + \alpha_3 s_{1t} + \alpha_4 s_{2t} + \alpha_5 s_{3t} \qquad (3)$$

In equation (3),s_1, s_2, and s_3 are seasonal dummies that control for seasonal cycles in real GDP of each country. While the addition of seasonal dummies does reduce the degrees of freedom, it ensures that the regression coefficients are capturing the appropriate movements in real GDP.

4.2. Decomposing the Real Price of Oil and Modeling Structural Shocks

The second model is similar to the approach employed by Kilian (2009). This model does not account for asymmetry in the relationship between oil prices and economic activity and treats oil shocks as endogenous. Following Kilian's approach, we first decompose the real price of oil into its three components – precautionary demand, supply, and aggregate demand. In order to do so, we carry out the following VAR:

$$A_0 z_t = \alpha + \sum_{i=1}^{24} A_i z_{t-i} + \varepsilon_t \qquad (4)$$

In equation (4), $z_t = (\Delta prod, rea_t, rpo_t)'$ where $\Delta prod_t$ is the percent change in global crude oil production, rea_t denotes the index of real economic activity as measured by the deflated Baltic Dry Index, and rpo_t refers to the real price of oil. All three series are collected at the monthly frequency and the lag length of the VAR is twenty four. The rea_t and rpo_t series are expressed in logs. ε_t denotes the vector of serially and mutually uncorrelated structural innovations. The VAR is used to identify the structural shocks to the global crude oil market. The residuals from this multivariate VAR form the following three series – oil supply shock, aggregate demand shock, and precautionary demand shock. Oil supply shocks are defined as exogenous shocks to global oil production. Aggregate demand shocks are changes in global real economic activity that cannot be explained by crude oil supply shocks. Finally, precautionary demand shocks are changes in the real price of oil that reflect changes in the demand for oil rather than demand for industrial commodities or supply of crude oil. Oil specific demand shocks may arise due to uncertainty about future oil supply or reflect changes in speculative demand. Since these shocks are obtained at the monthly frequency, we take three month averages to obtain quarterly series. Figure 5 plots the historical evolution of these structural shocks as implied by our model.

Kilian(2009) hypothesizes that the relationship between economic activity and changes in oil prices depends on the cause of the change in the latter, whether it be disruptions in oil supply, surge in global demand for commodities or speculation about future movements in oil prices. In order to test this hypothesis, we estimate the following regression for each country:

$$\Delta y_t = \alpha_j + \sum_{i=0}^{12} \beta_{ji} \hat{r}_{jt-i} + u_{jt}, \ \ j = 1,2,3 \qquad (5)$$

In equation (5), y_t is log levels of real GDP, $\hat{r}_{jt}, \ j = 1,2,3$ represents the three shocks - oil supply, aggregate demand, and precautionary demand. All three shocks are entered with twelve lags to maintain similarity to Kilian's specification. We run this regression equation by equation to make it more parsimonious. Although this may result in omitted variable bias, the effect would be minimal since the structural shocks are obtained from residuals that are orthogonal by design. To correct for seasonal trends previously identified in real GDP, we modify Kilian's model by adding seasonal dummies to equation (5). After adjusting for seasonal trends, the model has the following specification:

$$\Delta y_t = \alpha_j + \sum_{i=0}^{12} \beta_{ji} \hat{r}_{jt-i} + u_{jt} + s_{1jt} + s_{2jt} + s_{3jt}, \ \ j = 1,2,3 \qquad (6)$$

The results of both models are analyzed at the country level and the regional level as well as modified to include volatility in oil prices in the following section.

5. Results

In this section, we discuss the estimation results for our models and compare their findings. To analyze the effect of movements in oil prices on economic activity in emerging markets, we conduct F-tests for each country to determine if the parameters relating oil price variables to real GDP growth are statistically significant as a group. The results are presented in the form of p-values, in other words the probability of observing the actual or a higher F-value under the respective null hypotheses.

Table 4 presents the results for the F-tests of the net oil price increase model. We separate the results by region to ease analysis. Hamilton's study of the relationship between oil shocks and US GDP revealed that it would lose significance during a period of decreases in oil prices or a lack of net oil price increases. He found that although the parameters relating net oil price increases to GDP growth were statistically significant as a group during the period 1948:I to 1994:II, they lost their significance during the period 1973:IV to 1994:II(Hamilton 1996). While we cannot perform this exact test since data on emerging markets is not available prior to the 1980s with the exception of Korea and Israel, we perform a similar test for emerging markets by comparing statistical significance during the full sample and the period from 2000:I – 2009:IV. The full sample, if available, includes the late 1980s and the 1990s, which did not exhibit much movement in oil prices with the exception of the 1990 oil shock. The results of the regression with the full sample are reported by region in the first column of Table 4. The restricted sample is characterized by sharp increases in oil prices as well as the oil shock of 2007-2008, which makes it similar to the 1970s. The results of the regression with the restricted sample are reported in the second column of Table 4.

Seasonal dummies were included in both models to adjust for the seasonal trend in real GDP. While seasonally adjusted data is available for the US, such series are lacking for emerging market countries. Using seasonal dummies is a crude form of carrying out the required seasonal adjustment. The danger with using seasonally unadjusted data is that it may result in spurious correlation between oil prices and economic activity. The third column of Table 4 reports results of the regression with seasonal adjustments.

Table 5 presents the results for the F-tests of the structural shock model. We extend Hamilton's hypothesis to Kilian's model and run separate regressions for the period from 2000:I to 2009:IV. If Hamilton's hypothesis is correct, the presence of large oil shocks in this later period should affect the significance of one or more of the structural shocks, depending on the cause of the rise in oil prices in the recent decade. If the rise in oil prices was driven by a surge in economic activity, as has been proposed by Hamilton and Kilian, aggregate demand should acquire more statistical significance during the later period. The results for the full sample are reported in the first column of Table 5 while the results of the regression with the restricted sample are reported in the second column of Table 5. The third column of Table 5 reports results of the regression with seasonal adjustments.

5.1. Empirical Results for the Net Oil Price Increase Model

5.1.1. Asia

The regressions results from the net oil price increases model vary greatly within each region. For Asia, the relation between real GDP growth and net oil price increase for the full sample is only significant for Korea. Unlike other Asian countries, quarterly real GDP data is available for Korea since 1960. This allows the model to capture the shocks in 1970s as well as the late 2000s. All other countries have quarterly data beginning in the late 1980s or early 1990s. The inclusion of the 1970s shocks probably strengthens the relationship between Korean real GDP and oil prices. When the sample is restricted to 2000:I – 2009:IV, the relation between real GDP growth and oil price shocks also becomes significant for Malaysia and Thailand at the 10% and 5% significance level respectively. The change in significance confirms Hamilton's hypothesis since net oil price increases and its lags become jointly significant for more countries when the period with stagnant oil prices is removed from the sample. The p-value for Malaysia falls from 0.201 to 0.073. This reduction could also be attributed to Malaysia's change in net exports which have fallen from their 1989 peak of almost 400,000 barrels/day to less than 150,000 barrels/day in 2009[3]. The change in its net exports position implies that its domestic oil consumption is rising faster than its oil production. As Malaysia increases its oil consumption, its vulnerability to changes in the price of oil will also increase. The relation is insignificant for Indonesia and Philippines in both samples, however the p-value does decrease for both countries when the sample is restricted to 2000:I to 2009:IV. Although Indonesia has recently become a net oil importer, it was a net exporter for several decades prior[4]. This could explain the lack of statistical significance in the relationship between oil prices and real GDP growth for Indonesia. This is also consistent with the finding that it is easier to reject the null hypothesis that oil prices do not affect real GDP growth in Indonesia in the later period than in the full sample.

We find that the addition of seasonal dummies has a significant effect on the relation between oil prices and economic activity. The p-value for all Asian countries rises when seasonal dummies are included. The relation between real GDP growth and net oil price increases only remains significant for Korea. This indicates that the original regression results were partly motivated by a spurious correlation between oil prices and real GDP growth.

5.1.2. Central and South America

For Central and South America, the parameters relating net oil price increases to real GDP growth are not statistically significant as a group for any country in the full sample. When the sample is restricted to 2000:I to 2009:IV, the p-value falls for all countries and the relationship becomes statistically significant for Chile and Peru at the 5% significance level. The lack of statistical significance of net oil price increases for Argentina, Brazil, and Colombia is expected since these countries are net oil exporters. Oil price shocks would have a positive effect on the energy industry while having the opposite effect on all other

[3] Source: U.S. Energy Information Administration – Country Profile: Malaysia
[4] Source: U.S. Energy Information Administration – Country Profile: Indonesia

industries that now face higher costs. The net effect on a net exporter would depend on the contribution of energy industries to total GDP.

The addition of seasonal dummies has a mixed effect on the statistical significance of net oil price increases and its lags. While the p-value rises for Chile and falls for Brazil, the p-values for Argentina, Colombia, and Peru are not affected greatly. The change in Chile's p-value could imply that seasonal trends were creating spurious correlation between net oil price increases and real GDP growth. The change in Brazil's p-value implies the opposite – seasonal trends were reducing genuine correlation between net oil price increases and real GDP growth.

5.1.3. Central and Eastern Europe

For Central and Eastern Europe, the parameters relating net oil price increases to real GDP growth are statistically significant as a group for Hungary in the full sample but insignificant for all other countries. When the sample is restricted to 2000:I to 2009:IV, the p-values fall for most countries and the relationship becomes statistically significant for Hungary and Turkey at the 10% significance level. The lack of statistical significance for Russia is not surprising since its large oil exports buffer it against the negative effects of rising oil prices. Its p-value does fall from 0.427 to 0.103 when the sample is restricted to 2000:I to 2009:IV. This may indicate that Russia's net export position, which has doubled since 1999, is producing large enough gains such that the benefits from oil price shocks outweigh the losses. The lack of statistical significance for the Czech Republic, Poland, and the Slovak Republic is surprising since these countries are net importers of oil and have faced sharp rises in domestic oil consumption in the last decade.

The addition of seasonal dummies raises the p-value for Hungary, Poland, Russia, and Turkey while decreasing the p-value for Czech Republic and Slovak Republic. This implies that it is harder to reject the null hypothesis that oil prices do not affect real GDP growth for Hungary, Poland, and Russia and easier to reject the null hypothesis that oil prices do not affect real GDP growth for Czech Republic and Slovak Republic.

5.1.4. Middle East and North Africa

For the Middle East and North Africa, the sample is not representative of the region since data is unavailable at the quarterly frequency except for recent years. Of the three countries for which data is available, the relationship between net oil price increases and real GDP growth is insignificant for the full sample. When the sample is limited to the 2000:I to 2009:IV, the p-value increases for Israel and Morocco while decreasing for Jordan. Like Eastern Europe, the lack of statistical significance is surprising since all three countries are net importers of oil and have faced sharp rises in consumption in the last decade. The addition of seasonal dummies has little effect on the p-value, implying that seasonal trends did not distort the relationship between real GDP growth and net oil price increases.

5.2. Empirical Results for the Structural Shocks Model

5.2.1 Asia

The regression of real GDP growth on the various components of the real price of oil reveals that precautionary demand and its lags have a statistically significant effect on real GDP growth at the 5% significance level. This implies that real GDP growth is significantly affected by changes in speculative demand for oil and uncertainty in future oil supply. When the sample is restricted to 2000:I to 2009:IV, the F-test for precautionary demand and its lags becomes statistically significant for the entire region at the 1% level. This can be attributed to the 2007-2008 shock that was associated with high levels of speculative demand for oil.

The F-test for oil supply and its lags is also significant at the 5% significance level for Malaysia, Philippines, and Thailand. A look at the coefficients of oil supply and its lags reveals that they are mostly negative for Malaysia. This implies that despite Malaysia's net exporter position, it is negatively affected by global oil supply shocks. The opposite is true for Indonesia. Although the sign on most of its coefficients of oil supply and its lags is also negative, they are not jointly significant. This implies that despite its recently acquired net importer position, Indonesia's energy industry buffered it from the negative impact of global oil supply shocks over the full sample. When the sample is restricted to 2000:I to 2009:IV, the F-test for oil supply shocks and its lags becomes significant at the 5% significance level for the entire region. This implies that in recent years, net exporters and importers have been affected by global oil supply shocks.

The F-test for aggregate demand and its lags is not significant for any country except Thailand in the full and the restricted sample. Since these are emerging markets, they have been growing at rates at significantly higher than developed countries in North America and Europe. This could indicate the lack of statistical significance in the relationship between domestic GDP for Asian emerging markets and world economic activity.

The inclusion of seasonal dummies raises p-values for all three shocks for most countries sampled in Asia. Precautionary demand only remains statistically significant for Korea and the Philippines. Similarly, oil supply shocks only remain significant for Korea. Aggregate demand shock remains statistically insignificant except for Thailand and Malaysia. The addition of seasonal dummies makes it harder to reject the hypothesis that real oil prices do not have a statistically significant effect on economic activity through the components of precautionary demand shocks, oil supply shocks, and aggregate demand shocks.

5.2.2. Central and South America

For Central and South America, precautionary demand shocks and its lags are jointly significant for Argentina, Chile and Peru and jointly insignificant for Brazil and Colombia. When the sample is restricted to 2000:I to 2009:IV, precautionary demand shocks and its lags are jointly significant for all countries. This is similar to the pattern exhibited in Asia and could be attributed to the 2007-2008 oil shock that has a prominent effect on the later sample.

The F-test for oil supply shocks and its lags is statistically significant for all countries at the 5% significance level except Colombia. This pattern persists even when the sample is restricted to 2000:I to 2009:IV. The lack of statistical significance in the relationship between oil supply shocks and economic activity in Colombia could be due to the increase in its net export position over the recent years. Its oil production is rising faster than domestic consumption which could insulate it from any shortfalls of oil supply globally. The other net exporters of oil in the region are Argentina and Brazil. While the first is facing the opposite problem, the second has only recently become a net exporter of oil and is not insulated from oil supply shocks as yet.

Aggregate demand does not appear to have a statistically significant relationship with real GDP growth in the region, with the exception of Peru. In the restricted sample, p-values rise for most countries indicating that the past decade has increased the divergence between Central and South America and the rest of the world in terms of economic growth. This is consistent with the data on growth rates of real GDP in Latin America and the rest of the world.

The inclusion of seasonal dummies makes it harder to reject the hypothesis that the components of the real price of oil do not impact economic activity in Central and South America. The p-values rise for all three shocks for almost all the countries, thereby indicating that the seasonal trend has created spurious correlation in the original regressions.

5.2.3. Central and Eastern Europe

The real price of oil appears to have a statistically significant effect on countries in Central and Eastern Europe since all three components – precautionary demand shock, oil supply shock, and aggregate demand shock - are statistically significant at the 10% level with the exception of Turkey. In the full sample, we can reject the null hypothesis that precautionary demand shocks, oil supply shocks, and aggregate demand shocks do not affect the economies of Czech Republic, Hungary, Poland, and Russia. The statistical significance of aggregate demand suggests that growth in Central and Eastern Europe does not differ greatly from the rest of the world in the full sample. A look at growth rates of real

GDP reveals that Central and Eastern Europe are not growing as fast as other emerging markets in Asia and Latin America. This could explain why aggregate demand shocks are statistically significant for Central and Eastern Europe but not for other emerging markets.

Turkey, however, has a statistically significant relationship with oil supply shocks but not with precautionary shocks or aggregate demand shocks. This could imply two things – the Turkish economy is not affected by speculative demand for oil or uncertainty about future oil supplies and that its growth diverges from real GDP growth in the rest of the world. A look at real GDP growth in Turkey reveals that it has been growing at a much higher rate than the rest of Central and Eastern Europe, which explains the variance in the results within the region.

In the restricted sample from 2000:I to 2009:IV, the same results exist for precautionary demand shocks and oil supply shocks. However, aggregate demand loses its statistical significance in most countries in the restricted sample. This could indicate that the divergence between economic growth in the Eurasian region and the rest of the world has increased in the last decade, a pattern that is true of most developing markets.

The addition of seasonal dummies raises p-values for all the F-tests for each of the shocks. Precautionary demand shocks remain significant for Russia and Turkey while supply shocks and aggregate demand shocks no longer seem to affect Eurasian economies. This is consistent with the pattern displayed in other regions where adjusting for the seasonal trend removes what may have been spurious correlation between the variables.

5.2.4. Middle East and North Africa

The F-tests for precautionary demand shock and oil supply shock are statistically significant at the 10% level for Israel and Jordan in the full as well as the restricted sample. The F-test for aggregate demand is statistically insignificant for Israel in both samples and for Jordan in the later sample. The p-values are higher in the restricted sample implying that economic growth in both countries diverges from the rest of the world in the past decade. Morocco, however does not show statistical significance for any of the shocks but displays a similar fall in p-value for the aggregate demand shock from the full to the restricted sample.

The addition of seasonal dummies, like in all other regions, raised p-values for the all the F-tests for each of the shocks. Precautionary demand shocks only remain significant for Israel while all other shocks are statistically insignificant for all three countries. As expected, seasonal trends may indicate correlation where there is none and their removal reduces statistical significance for the components of the real price of oil.

5.3. Alternative empirical analyses

5.3.1. Oil Price Volatility

The above section focused on the response of growth rates of real GDP to asymmetric shocks and structural shocks in the real price of oil. While the models proposed by Hamilton and Kilian dominate the literature on oil price shocks, it is useful to expand the analysis to consider the effects of oil price volatility. Hamilton(2003) proposed that one of the channels through which oil shocks affect economic activity is the deferral of large purchases by consumers due to uncertainty about the future price of oil. This uncertainty can be measured by the volatility in oil prices since one would expect that a lack of information about future prices would increase volatility.

Ferderer (1996) performed empirical analysis on the relationship between industrial production in the United States and oil price volatility, calculated as a moving standard deviation. His hypothesis is based on the theoretical work that shows that oil price uncertainty might be as important a determinant of economic activity as the level of oil prices. He finds that oil price volatility contains information independent of oil price levels that is useful in forecasting economic growth. We perform a similar test using real GDP data for emerging markets. We carry out the following regressions for each country:

$$\Delta \mathrm{y_t} = \alpha_0 + \sum_{i=1}^{4} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{4} \alpha_{2i} vol_{t-i}^{\#} \qquad (7)$$

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{4} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{4} \alpha_{2i} o_{t-i}^{\#} + \sum_{i=1}^{4} \alpha_{3i} vol_{t-i}^{\#} \qquad (8)$$

In equation (7), y_t is log level of real GDP, and $vol_{t-1}^{\#}$ is the volatility in the real price of oil calculated as the quarterly standard deviation of monthly oil prices. In equation (8), we add $o_{t-i}^{\#}$, the NOPI as measured by Hamilton, as a control variable[5]. The results of the F-test of the hypothesis that oil price volatility and its lags do not affect growth rates of real GDP can be found in Table 6, where column one and two are for equations (7) and (8) respectively. When we do not control for changes in the level of oil prices, we find that oil price volatility is significant for several countries, such as Malaysia and Thailand in Asia, Brazil and Peru in South America, and all of Central and Eastern Europe with the exception of Poland and the Czech Republic. When we introduce net oil price increases as a control variable, we find that p-values increase for almost all the countries. Oil price volatility is not significant for any country in Asia, Central and South America, and the Middle East and Africa, with the exception of Malaysia and Brazil. Oil price volatility does appear to be significant for several countries in Central and Eastern Europe. The fall in significance indicates that oil price volatility does not contain information independent of oil price levels that is useful in forecasting economic growth. This contradicts Ferderer's finding for the US. However, it must be taken into consideration that Ferderer's dataset includes the 1970s and 1980s, periods during which oil prices were extremely volatile. If data was available for most emerging market countries dating back to the 1970s, we may observe different results.

5.3.2. Agriculture Price Shocks

The empirical analyses for the relationship between oil prices and economic activity does not reveal a consistent pattern within emerging markets. While the relationship is significant for several countries, especially in the last decade, it is unclear if oil price

[5] We also carry out the test using alternative measures of oil price shocks such as the percentage change in real oil prices, but it does not change our results significantly. These results can be found in Table 7.

shocks impact economic activity as they do for developed countries. An explanation for the lack of significance could be that emerging markets have not developed the dependence on oil that is found in developed countries. Instead, many of them are dependent on agricultural commodities, whether it is for sustenance or export. As shown in Table 3, the contribution of agriculture to GDP is significantly higher in emerging markets than in developed regions.

If emerging markets are indeed more dependent on agricultural commodities than on oil, we should find that statistical significance is greater for the former than the latter in emerging markets. In this section, we carry out empirical tests for the relationship between real GDP and agricultural price shocks. The world price of agricultural commodities is measured by the World Bank Agriculture Commodity Price Index. This index is calculated at the monthly level and converted to a quarterly series by using the mid-month observation. We deflate each observation using the US CPI since we want to measure real rather than nominal changes in the prices of agricultural commodities. The modified index is depicted in Figure 6. We carry out the following regression for each country:

$$\Delta \mathrm{y_t} = \alpha_0 + \sum_{i=1}^{4} \alpha_{1i} \Delta y_{t-i} + \sum_{i=1}^{4} \alpha_{2i} \Delta agri_{t-i} \qquad (9)$$

In equation (9), y_t is log level of real GDP, and $agri_{t-i}$ is the log level of the real agricultural index. Table 8 provides the results of the F-test of the hypothesis that agricultural price shocks and its lags do not affect real GDP. We find that agriculture price shocks are significant for more than half the countries at the 5% level. This is far greater than the significance observed for oil price shocks in emerging markets. Since agricultural commodity prices are determine at the global level, it is unlikely that emerging markets affect these prices. If we accept this as validation for the exogeneity of agriculture price shocks, these results illustrate the relative importance of agricultural commodities over oil in emerging markets.

6. Conclusion

This paper analyzes the oil price – macroeconomy relationship by applying the two leading approaches pioneered by Hamilton and Kilian to emerging markets. While researchers have conducted regional and country-specific studies, the major contribution of this paper is in applying the net oil price increase model and the structural shocks model to emerging markets and capturing the oil price shock of 2007-2008.

Our main results show that oil price shocks as measured by net increases do not produce a consistent effect on emerging markets. While the relationship is significant for certain countries, we are unable to reject the hypothesis that net oil price increases do not affect economic activity during the full sample for most countries. It is interesting to note that most net oil exporters fall into the latter category. When the sample is limited to the last decade, it becomes easier to reject the hypothesis for most countries. This is consistent with Hamilton's hypothesis that a period dominated by oil price increases will have higher statistical significance.

Our structural shocks model throws light on the effect of speculative demand for oil on real economic activity. The statistical significance of precautionary demand suggests that emerging markets are not hedging against speculative movements in real oil prices, which could be a result of weak financial markets. The statistical significance of supply shocks is not surprising since most of these countries do not have large reserves to fall back upon. This differs from the finding in the net oil price increase model. Supply shocks, as measured by Kilian's model allow for more volatility compared to Hamilton's net oil prices increases. This could explain the difference in the findings. The lack of statistical significance of aggregate demand shocks is consistent with the divergence in economic growth in emerging markets and the rest of the world.

Testing for oil price volatility reveals that it does not carry information independent of movements in oil prices, a finding that is contrary to Ferderer's results for the US. Testing for agriculture price shocks, however, does reveal a statistically significant relationship between movements in agriculture prices and economic activity. This could be an opportunity for future research, particularly the interaction between oil price shocks and agriculture price shocks.

Future research could also consider applying other nonlinear measures of oil shocks to emerging markets as well as controlling for the effect of changes in country- specific exchange rates. Adjusting for the energy specific regulatory environment in each country would also add an interesting dimension to the study of oil prices and economic activity. While it is difficult to reach a single conclusion about the effect of oil price shocks on economic activity in emerging markets, our study does reveal some notable findings about hedging against changes in oil prices, differences between net oil importers and exporters, and the effect of the 2007-2008 oil price shock.

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8. Appendix: Tables and Figures

Table 1: Data Series

	Source	Availability*
Oil Prices		
Refiner Acquisition Cost	US Department of Energy	January 1974 - December 2010
Oil Production		
World Crude Oil Production	US Department of Energy	January 1974 - December 2010
Economic Activity		
Real GDP	IMF International Financial Statistics Database	Varies by country
Baltic Dry Index	Bloomberg	January 1985 - December 2010
Consumer Prices		
US CPI	US Department of Labor	January 1974 - December 2010
Agriculture Prices		
World Bank Agriculture Price Index	Global Financial Database	January 1974 - December 2010
Sectoral Composition		
GDP Sector Shares	World CIA Factbook	Varies by country
Computed Series		
Real Oil Prices	Refiner Acquisition Cost * 100/ US CPI	
Real Baltic Dry Index	Baltic Dry Index * 100/ US CPI	
Real Agriculture Price Index	WB Agriculture Price Index *100/ US CPI	

**Monthly series are made into quarterly series using midmonth observations*

Table 2: Real GDP Availability for Emerging Markets

	Availability
Asia	
Indonesia	Q1:1997 - Q3:2010
Korea	Q1:1960 - Q3: 2010
Malaysia	Q1:1991 - Q3:2010
Philippines	Q1:1981 - Q1:2010
Thailand	Q1:1993 - Q3:2010
Central and South America	
Argentina	Q1:1993 - Q3:2010
Brazil	Q1:1995 - Q3:2010
Chile	Q1:1996 - Q4:2009
Colombia	Q1:1994 - Q2:2010
Peru	Q1:1979 - Q3:2010
Central and Eastern Europe	
Czech Republic	Q1:1994 - Q3:2010
Hungary	Q1:1995 - Q3:2010
Poland	Q1:1995 - Q3:2010
Russian Federation	Q1:1995 - Q3:2009
Slovak Republic	Q1:1993 - Q3:2010
Turkey	Q1:1987 - Q3:2010
Middle East and North Africa	
Israel	Q1:1971 - Q3:2010
Jordan	Q1:1992 - Q1:2010
Morocco	Q1:1990 - Q4:2009

Source: IMF IFS Database

Table 3.1 : Growth Rates of Real GDP

	Average 1992-2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2015
										World Bank Projections		
World	3.2	2.9	3.6	4.9	4.5	5.1	5.2	3	-0.6	4.2	4.3	4.6
Emerging Markets	3.8	4.8	6.2	7.5	7.1	7.9	8.3	6.1	2.4	6.3	6.5	6.7
Advanced Economies	2.8	1.7	1.9	3.2	2.7	3	2.8	0.5	-3.2	2.3	2.4	2.3
Asia												
Indonesia	3.6	4.5	4.8	5.0	5.7	5.5	6.3	6.0	4.5	6.0	6.2	7.0
Korea	6.0	7.2	2.8	4.6	4.0	5.2	5.1	2.3	0.2	4.5	5.0	4.0
Malaysia	6.2	5.4	5.8	6.8	5.3	5.8	6.2	4.6	-1.7	4.7	5.0	5.0
Philippines	3.3	4.4	4.9	6.4	5.0	5.3	7.1	3.8	0.9	3.6	4.0	4.0
Thailand	3.8	5.3	7.1	6.3	4.6	5.1	4.9	2.5	-2.3	5.5	5.5	5.0
Central and South America												
Argentina	2.7	-10.9	8.8	9.0	9.2	8.5	8.7	6.8	0.9	3.5	3.0	3.0
Brazil	2.6	2.7	1.1	5.7	3.2	4.0	6.1	5.1	-0.2	5.5	4.1	4.1
Chile	6.0	2.2	4.0	6.0	5.6	4.6	4.6	3.7	-1.5	4.7	6.0	4.5
Colombia	2.7	2.5	4.6	4.7	5.7	6.9	7.5	2.4	0.1	2.2	4.0	4.5
Peru	3.8	5.0	4.0	5.0	6.8	7.7	8.9	9.8	0.9	6.3	6.0	5.8
Central and Eastern Europe												
Czech Republic		1.9	3.6	4.5	6.3	6.8	6.1	2.5	-4.3	1.7	2.6	3.5
Hungary	2.5	4.4	4.3	4.9	3.5	4.0	1.0	0.6	-6.3	-0.2	3.2	3.0
Poland	4.6	1.4	3.9	5.3	3.6	6.2	6.8	5.0	1.7	2.7	3.2	4.0
Russian Federation		4.7	7.3	7.2	6.4	7.7	8.1	5.6	-7.9	4.0	3.3	5.0
Slovak Republic		4.6	4.8	5.0	6.7	8.5	10.6	6.2	-4.7	4.1	4.5	4.2
Turkey	3.0	6.2	5.3	9.4	8.4	6.9	4.7	0.7	-4.7	5.2	3.4	4.0
Middle East and North Africa												
Israel	5.3	-0.7	1.5	5.0	5.1	5.3	5.2	4.0	0.7	3.2	3.5	3.7
Jordan	5.1	5.8	4.2	8.6	8.1	8.0	8.9	7.8	2.8	4.1	4.5	5.5
Morocco	2.4	3.3	6.3	4.8	3.0	7.8	2.7	5.6	5.2	3.2	4.5	5.0

Source: World Economic Outlook, April 2011

Table 3.2 : Sectoral Composition of GDP

	Agriculture (% of GDP)	Industry (% of GDP)	Services (% of GDP)
World	5.70%	30.70%	63.60%
Asia			
Indonesia	15%	48%	37%
Korea	3%	39%	58%
Malaysia	6%	17%	78%
Philippines	14%	31%	55%
Thailand	12%	43%	45%
Central and South America			
Argentina	6%	32%	62%
Brazil	6%	25%	69%
Chile	6%	41%	54%
Colombia	10%	37%	53%
Peru	6%	33%	53%
Central and Eastern Europe			
Czech Republic	2%	38%	60%
Hungary	3%	31%	66%
Poland	5%	28%	67%
Russian Federation	5%	35%	61%
Slovak Republic	3%	36%	62%
Turkey	9%	26%	65%
Middle East and North Africa			
Israel	2%	33%	65%
Jordan	3%	30%	66%
Morocco	17%	32%	51%

Source: World CIA Factbook

Table 3.3: Net Import Position (Thousands Barrels/Day)

	2006	2007	2008	2009
World	-767.0	-1707.3	-167.1	-62.0
<u>Asia</u>				
Indonesia	-157.2	-186.2	-208.3	-245.1
Korea	-2160.2	-2211.2	-2101.3	-2139.4
Malaysia	197.3	159.7	191.8	139.0
Philippines	-306.6	-289.5	-270.3	-288.4
Thailand	-627.4	-621.1	-604.3	-601.4
<u>Central and South America</u>				
Argentina	258.6	202.3	188.0	214.5
Brazil	-122.0	-72.5	-45.9	55.2
Chile	-261.5	-271.3	-287.3	-286.9
Colombia	273.9	266.1	314.7	406.8
Peru	-51.8	-50.7	-50.8	-34.6
<u>Central and Eastern Europe</u>				
Czech Republic	-195.4	-197.5	-199.8	-195.2
Hungary	-124.5	-128.3	-121.2	-120.3
Poland	-464.7	-486.7	-497.8	-501.2
Russian Federation	6873.9	7181.0	7004.1	7193.7
Slovak Republic	-67.4	-78.6	-75.2	-71.5
Turkey	-633.6	-645.0	-629.3	-526.5
<u>Middle East and North Africa</u>				
Israel	-245.8	-237.8	-230.0	-231.0
Jordan	-107.9	-103.4	-94.9	-95.9
Morocco	-176.7	-179.2	-191.1	-200.1

Source: US Department of Energy

Table 4: Net Oil Price Increase Model*

	Full Sample**	2000 - 2009	Full Sample with Seasonal Dummies
<u>Asia</u>			
Indonesia	0.971	0.833	0.999
Korea	0.029	0.047	0.038
Malaysia	0.201	0.073	0.327
Philippines	0.755	0.584	0.784
Thailand	0.139	0.003	0.193
<u>Central and South America</u>			
Argentina	0.999	0.695	0.925
Brazil	0.514	0.262	0.169
Chile	0.283	0.011	0.552
Colombia	0.842	0.671	0.885
Peru	0.602	0.046	0.518
<u>Central and Eastern Europe</u>			
Czech Republic	0.370	0.105	0.199
Hungary	0.003	0.006	0.045
Poland	0.728	0.652	0.941
Russian Federation	0.427	0.103	0.449
Slovak Republic	0.708	0.652	0.579
Turkey	0.377	0.090	0.527
<u>Middle East and North Africa</u>			
Israel	0.350	0.655	0.362
Jordan	0.233	0.216	0.189
Morocco	0.432	0.825	0.498

*Reported values are p-values of F-test of NOPI and its lags

**Full sample varies for each country due to limited data availability

Table 5: Structural Shocks Model*

	Full Sample**			2000 - 2009			Full Sample with Seasonal Dummies		
	Precautionary Demand	Oil Supply	Aggregate Demand	Precautionary Demand	Oil Supply	Aggregate Demand	Precautionary Demand	Oil Supply	Aggregate Demand
Asia									
Indonesia	0.002	0.122	0.756	0.000	0.000	0.463	0.481	0.856	0.983
Korea	0.046	0.243	0.244	0.000	0.004	0.609	0.008	0.023	0.682
Malaysia	0.018	0.001	0.790	0.000	0.001	0.362	0.274	0.502	0.077
Philippines	0.003	0.046	0.084	0.001	0.017	0.592	0.031	0.533	0.388
Thailand	0.004	0.000	0.047	0.001	0.007	0.059	0.638	0.551	0.092
Central and South America									
Argentina	0.001	0.000	0.108	0.000	0.002	0.199	0.970	0.530	0.871
Brazil	0.167	0.044	0.584	0.000	0.000	0.213	0.559	0.848	0.416
Chile	0.000	0.015	0.227	0.002	0.050	0.579	0.076	0.479	0.384
Colombia	0.349	0.689	0.118	0.067	0.454	0.192	0.265	0.651	0.079
Peru	0.000	0.037	0.052	0.002	0.009	0.535	0.439	0.500	0.709
Central and Eastern Europe									
Czech Republic	0.000	0.000	0.078	0.000	0.000	0.225	0.245	0.716	0.480
Hungary	0.000	0.000	0.056	0.000	0.001	0.314	0.276	0.161	0.248
Poland	0.000	0.000	0.083	0.000	0.001	0.420	0.509	0.373	0.818
Russian Federation	0.001	0.000	0.004	0.000	0.001	0.045	0.048	0.440	0.146
Slovak Republic	0.003	0.000	0.027	0.003	0.000	0.046	0.132	0.625	0.425
Turkey	0.419	0.000	0.840	0.000	0.005	0.464	0.051	0.131	0.077
Middle East and North Africa									
Israel	0.002	0.057	0.464	0.011	0.016	0.919	0.022	0.028	0.227
Jordan	0.001	0.000	0.048	0.000	0.006	0.214	0.128	0.948	0.757
Morocco	0.325	0.553	0.910	0.604	0.687	0.325	0.352	0.516	0.932

*Reported values are p-values of F-test of structural shocks and their lags

**Full sample varies for each country due to limited data availability

Table 6: Volatility of Real Oil Prices

	Volatility	Volatility while controlling for NOPI
Asia		
Indonesia	0.966	0.940
Korea	0.190	0.433
Malaysia	0.010	0.079
Philippines	0.951	0.973
Thailand	0.010	0.066
Central and South America		
Argentina	0.855	0.850
Brazil	0.029	0.057
Chile	0.106	0.389
Colombia	0.804	0.751
Peru	0.709	0.817
Central and Eastern Europe		
Czech Republic	0.111	0.301
Hungary	0.000	0.000
Poland	0.377	0.485
Russian Federation	0.020	0.095
Slovak Republic	0.067	0.102
Turkey	0.009	0.017
Middle East and North Africa		
Israel	0.888	0.780
Jordan	0.803	0.859
Morocco	0.163	0.342

*Reported values are p-values of F-test of volatility and its lags

**Sample varies for each country due to limited data availability

Table 7: Volatility of Real Oil Prices

	Volatility	Volatility while controlling for % Change in Oil Prices
Asia		
Indonesia	0.966	0.898
Korea	0.190	0.302
Malaysia	0.010	0.106
Philippines	0.951	0.913
Thailand	0.010	0.165
Central and South America		
Argentina	0.855	0.690
Brazil	0.029	0.026
Chile	0.106	0.224
Colombia	0.804	0.743
Peru	0.709	0.697
Central and Eastern Europe		
Czech Republic	0.111	0.016
Hungary	0.000	0.000
Poland	0.377	0.336
Russian Federation	0.020	0.013
Slovak Republic	0.067	0.032
Turkey	0.009	0.016
Middle East and North Africa		
Israel	0.888	0.804
Jordan	0.803	0.229
Morocco	0.163	0.248

*Reported values are p-values of F-test of volatility and its lags

**Sample varies for each country due to limited data availability

Table 8: Agriculture Price Shocks

	% Change in Real Agriculture Index
Asia	
Indonesia	0.869
Korea	0.019
Malaysia	0.004
Philippines	0.498
Thailand	0.010
Central and South America	
Argentina	0.274
Brazil	0.001
Chile	0.359
Colombia	0.406
Peru	0.870
Central and Eastern Europe	
Czech Republic	0.139
Hungary	0.005
Poland	0.451
Russian Federation	0.008
Slovak Republic	0.016
Turkey	0.132
Middle East and North Africa	
Israel	0.845
Jordan	0.189
Morocco	0.884

*Reported values are p-values of F-test of agriculture index and its lags

**Sample varies for each country due to limited data availability

Figure 1: Historical Trends in Oil Prices

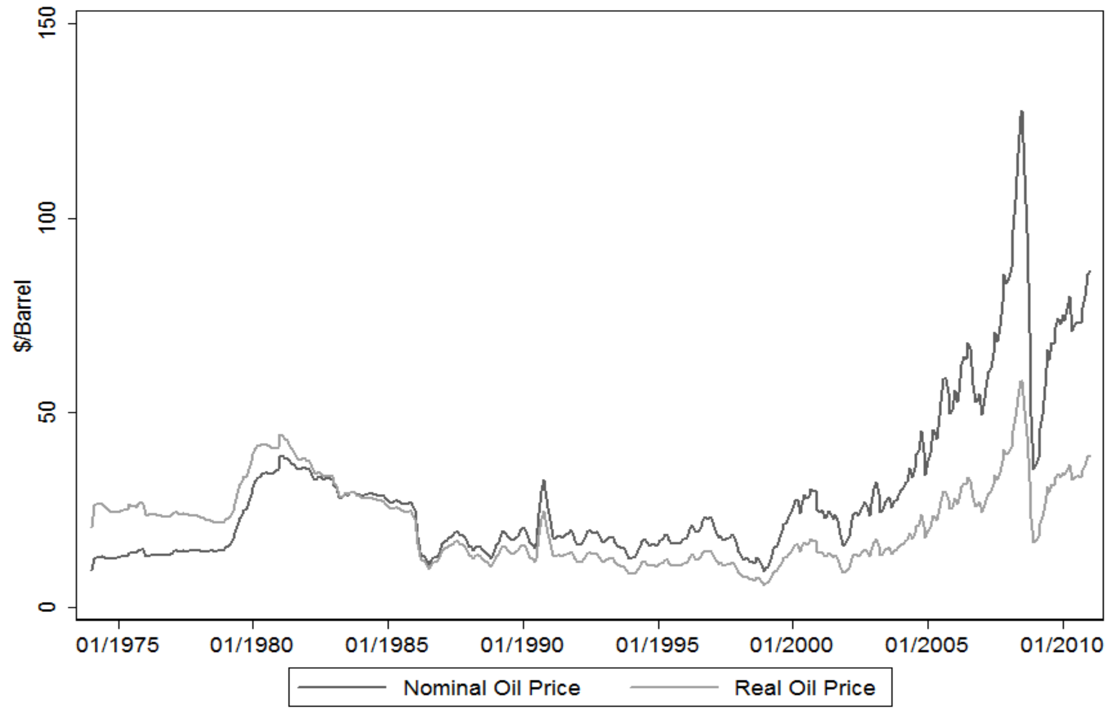

Figure 2: Historical Trends in World Oil Production

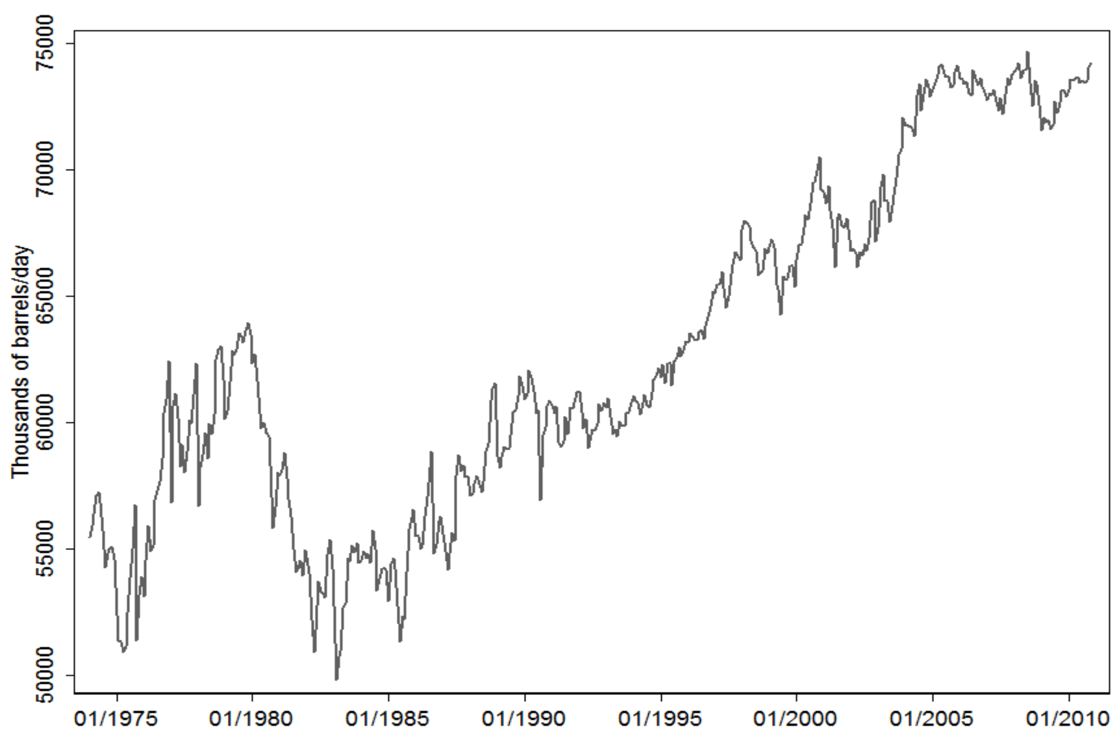

Figure 3: Trends in Global Freight Rates

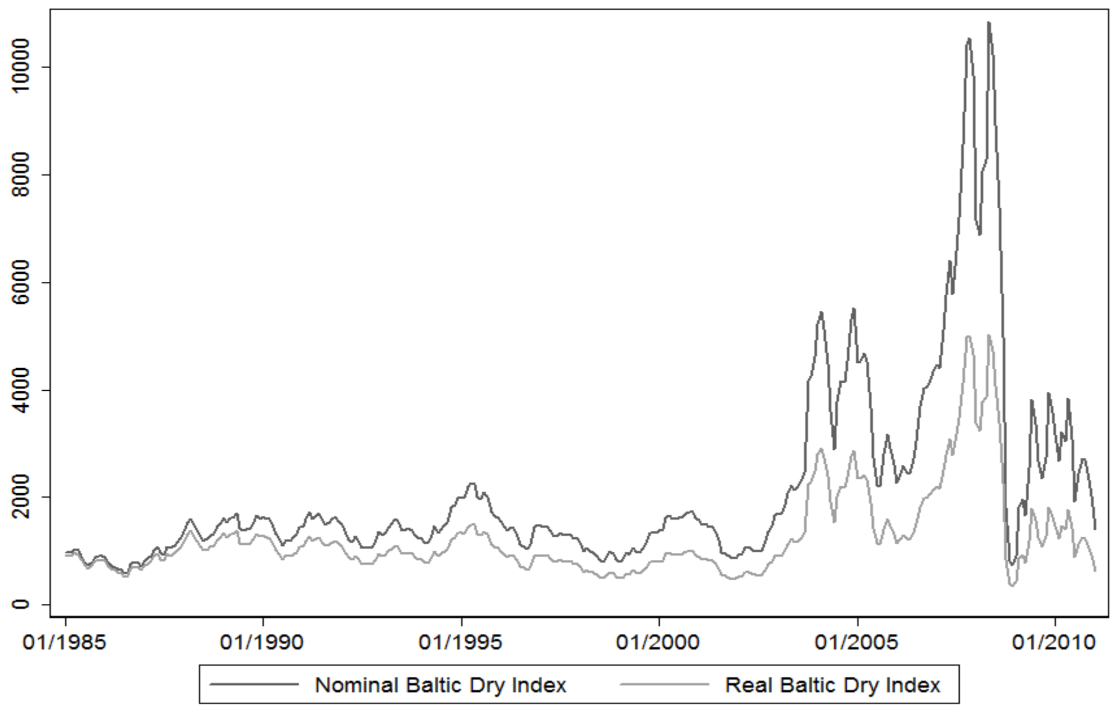

Figure 4: Real Net Oil Price Increases

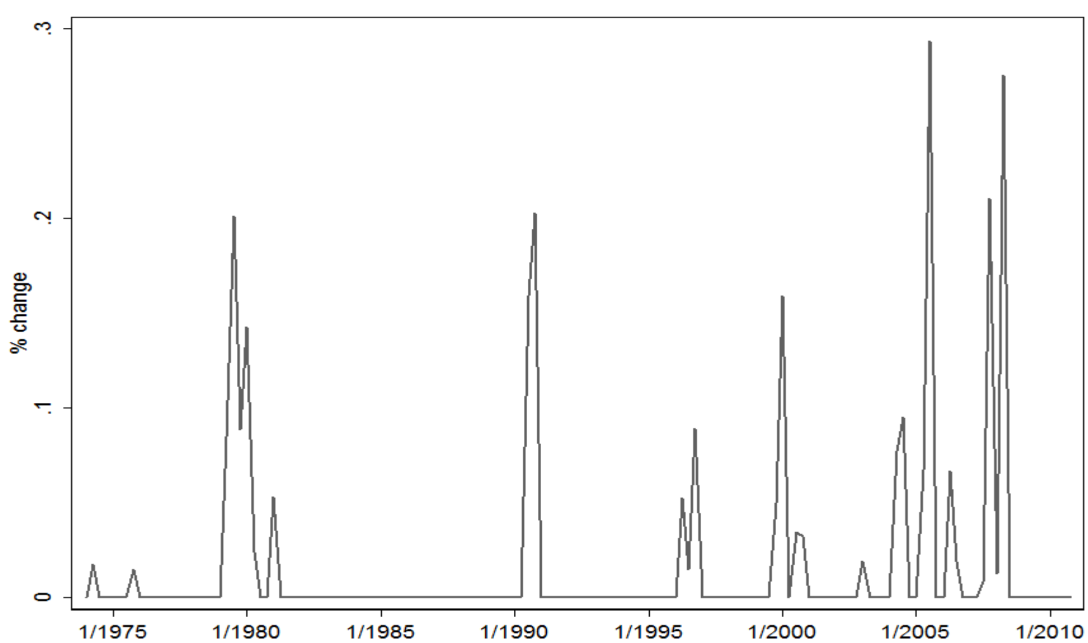

Figure 5: Structural Shocks to the Real Price of Oil

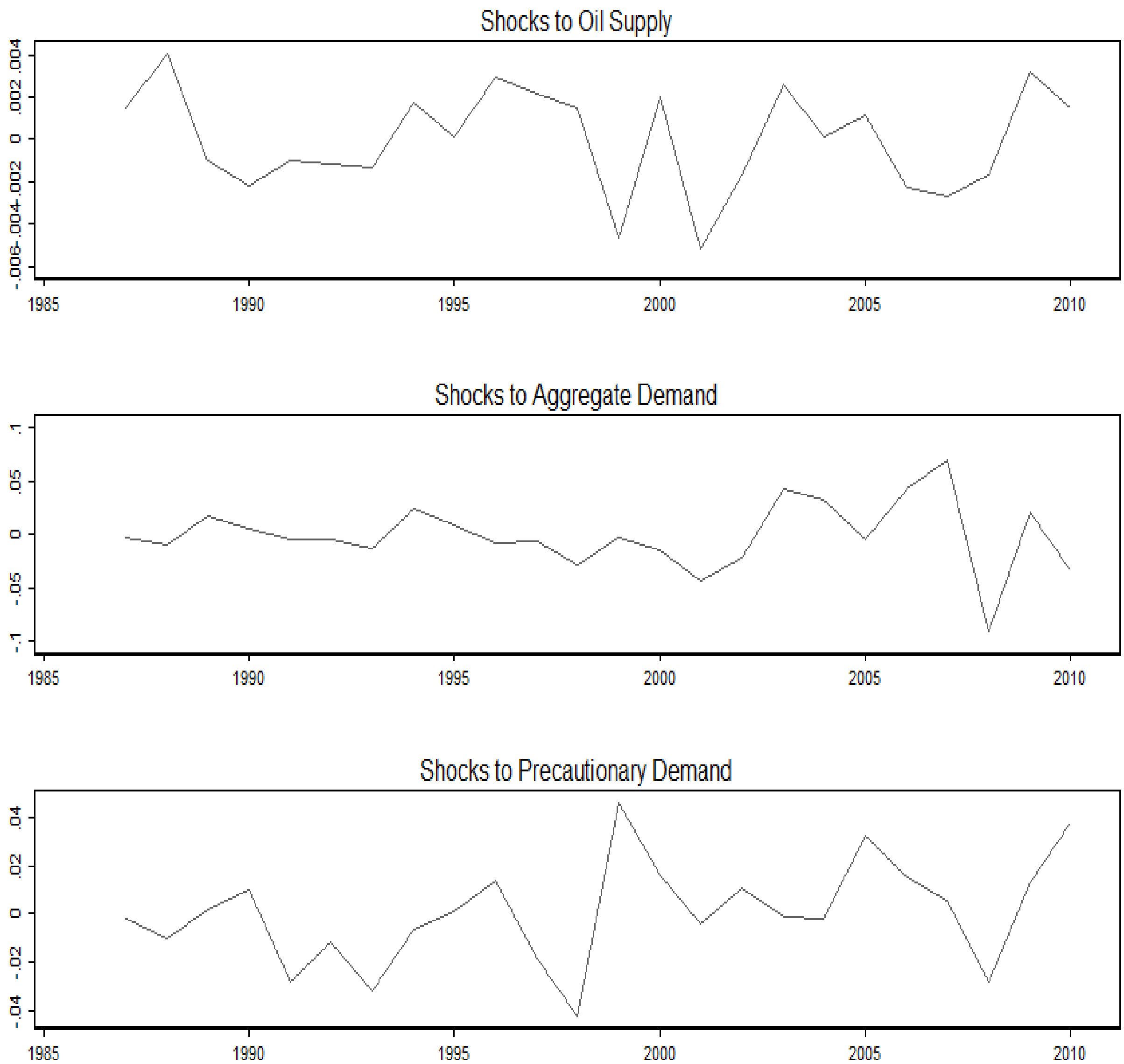

Figure 6: Percent Changes in Agriculture Prices