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Peaks, Spikes, and Barrels: Modeling Sharp Movements in Oil Prices

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Abstract

Global oil markets were roiled by sharp price swings in 2008, and economists are still divided over the reasons for the unusual volatility. Those emphasizing fundamentals point to inelastic supply and demand curves, others view the phenomenon mostly as a result of financial investors flocking into commodity markets. This paper attempts to infer the strength of these competing hypotheses, using a simultaneous equation model that enables us to undertake a separate analysis of supply and demand factors. The model broadly captures both the surge and subsequent fall in prices, with a particularly strong impact of demand factors. The model captures a strong effect of a measure for global liquidity but does not find support for a speculative motive.

JEL Classification Numbers:

Keywords: oil price, consumption demand, supply, asset demand, speculation

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I. INTRODUCTION

The oil price is a key variable in the global economy because of its effects on world economic growth and external imbalances. Even if measured in real terms, oil prices fluctuated wildly in recent years, having a significant impact on growth and inflation, and leading to swings in current account balances for both oil-importing and exporting countries, with concomitant effects on net foreign asset positions.

After turbulent phases in the 1970s and 1980s, the oil price was fairly stable through the mid-2000s. It rose gradually to about US$75 per barrel in the third quarter of 2007, but sharply spiked upward to more than US$140 per barrel in July 2008. When world economies began to weaken in early 2008, the oil price followed suit and dived to US$40 per barrel at the end of 2008. Since then it has risen back to the levels experienced prior to the spike, currently trading in a range between US$70 and US$85 per barrel. In response to lingering uncertainties about economic growth in China and the Euro zone and concerns that the global economic recovery may not progress as fast as had been hoped, a number of analysts have lowered their short-term oil price forecasts. For example, the EIA now projects oil prices to remain within the current trading range through end 2011.

In recent years, views on the price of oil have also become influenced by concerns about the availability of oil supply going forward, most prominently expressed in the "peak oil" theory. The latest IEA forecast indeed shows that oil production in 2020 is projected to be about 11 percent below the level projected three years ago for the same year. Similarly, the IEA only projects an annual increase in oil supply of 1 million barrels per day through 2015, with production outside OPEC either declining or stagnant at best. Incidentally, both reports also suggest that rising oil demand will largely stem from non-OECD markets since, for the OECD region, the ongoing decline in oil intensity is projected to offset the positive effects from output growth.

Among economists, traditional demand and supply factors are still being seen to play the most prominent role in the explanation of oil price movements. Several papers have argued that the observed price swings were consistent with extremely inelastic supply and demand curves, with small shifts in either curve having a large impact on prices. Hamilton (2009) argues that the price elasticity of demand may be as low at 0.06–0.1; indeed, he favors the lower estimate based on the behavior of inventories during the recent cycle. He notes that fixed price elasticity is unable to explain both the price surge and the subsequent sharp decline, but finds that a small upward shift in the price elasticity during the crisis would be sufficient to replicate recent oil price developments. Kilian (2010) has shown that the unexpected increase in the demand for oil after 2002 was driven to a large extent by unexpected growth from countries outside of the OECD, and that much of the decline in the real price of oil can be explained by the large negative growth shocks in emerging and in advanced economies.

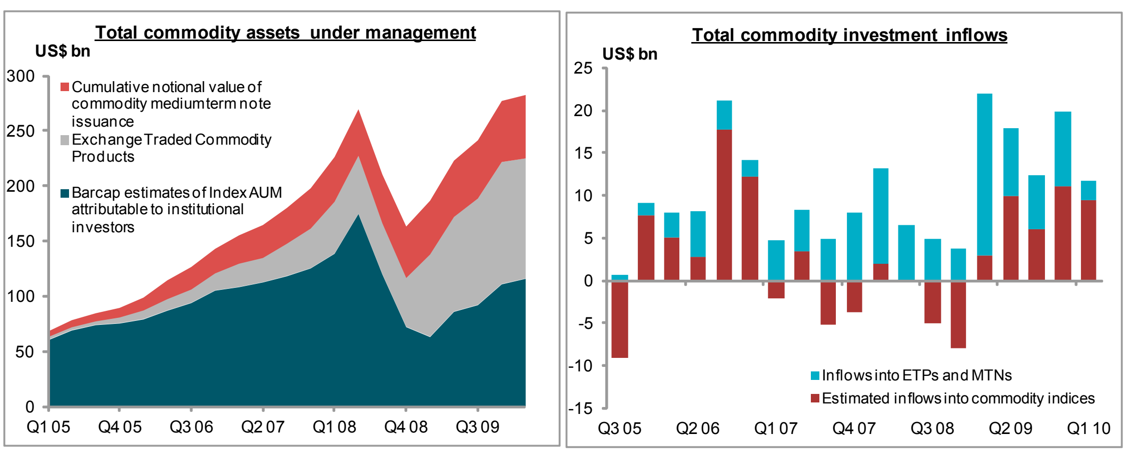
A somewhat competing, albeit not necessarily contradictory view, is that financial flows have provided a significant stimulus to oil demand and prices in recent years. This could have happened in two ways:

- First, looser global monetary conditions could have depressed rates, prompting a search for higher yield that could explain the recent rise in commodity investments.

- Second, oil could have been subject to a speculative bubble, as funds were being drawn into commodities to profit from expectations of rising prices.

Taking these two possibilities in turn, there is evidence that, among investment portfolios, sizeable funds have been directed into more diversified baskets that include oil futures and commodity index funds.[1] According to Barclay's Capital Commodity Research, commodity assets under management rose from about US$70 billion in early 2005 to about US$270 billion in Q2 2008 (Figure 1). This may have put upward pressure on oil prices as spot prices are in part determined by the futures curve, and vice versa as the value of commodity assets subsequently fell.[2] On the other hand, the value of commodity investments is of course heavily influenced by commodity prices themselves, leaving the volume of investments a potentially more relevant measure. Absent the necessary data, investment volumes can be closely proxied by fund inflows. The peaks in inflows occur considerably prior to the peak in the value of assets under management, suggesting that the commodity investment channel may not be as strong as originally thought.

Figure 1. Commodity Investments



Sources: Bloomberg, MTN-I, ETP issuer data, Barclays Capital.

[1] These flows do not necessarily represent physical holdings of commodities because there is no obligation to hold a contract to expiry and few users of commodity exchanges ever take physical delivery.

[2] The more recent surge into commodity assets has been largely associated with precious metals rather than oil futures.

On the issue of speculative bubbles, the rapid upward as well downward shift in prices have invited comments that neither fundamental forces nor portfolio shifts may have been the only factors at work. Indeed, several number of market participants have argued that the rapid expansion of commodity markets has contributed to expectations of rising prices:

> "*Speculators have expended tens of billions of dollars in U.S. energy commodity markets... [and] Speculation has contributed to rising U.S. energy prices*." (U.S. Senate, 2006).

> "*.. although the weak dollar, ebbing Middle Eastern supply and record Chinese demand could explain some of the increase in energy prices, the crude oil market has been significantly affected by speculation*" (Soros, 2008).[3]

The empirical evidence on whether commodity funds have contributed to the recent price surge has not focused on separating the two effects, partly because of data limitations. In terms of the effects of global liquidity on commodity prices, results are mixed. Ruffer and Stracca (2006) look at linkages between excess liquidity and macroeconomic variables, finding that a composite real asset price index that incorporates property and equity prices does not show any significant reaction to a global liquidity shock. On the other hand, Belke and others (2010) find that global liquidity is a useful indicator of commodity price inflation. In studies focusing on commodity investments, Gilbert (2008) finds no evidence of the impact of investor activity on the prices of metals or maize, but finds that futures positions of index providers have affected soybean prices. Korniotis (2009) supports the view of weak linkages in his finding that the co-movement between metals prices associated with spot and futures contracts has not weakened in recent years as commodity asset demand has risen. Since futures contracts are included in commodity index funds while spot contracts are not included, it would appear that commodity index funds have no independent impact on prices.

Part of the problem in inferring a direct relationship between oil prices and speculative variables is in the definition of speculation, and whether the definition can be matched by data. The main indicator used to assess the role of speculation is the difference between long and short holdings of oil futures contracts by noncommercial investors since it is argued that these investors are most likely to be speculators because they are not purchasing oil futures for commercial reasons. However, many investors in this category represent managed funds, pension funds and other institutional investors that seek exposure to commodity prices as an asset class in an unleveraged and passively-managed manner. Notwithstanding these concerns, Granger-causality tests generally fail to support the null hypothesis of causality (see IMF 2006, 2008.)

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[3]See Davidson (2008) for additional sources.

Supporting evidence that speculation is not the source of the recent price surge comes from the behavior of inventories. Price increases from speculation would normally lead to inventory holding in anticipation of higher profits; the higher inventory holdings would then lead to reduced price pressures and eventually restore equilibrium (on the latter effect, Ye and others (2006) show that higher OECD inventories lead to lower oil prices). However, the price surges for oil and metals did not lead to inventory holding, suggesting that the speculative motive in the commodity price surge is weak (Krugman 2008, Hamilton 2009).

In light of the above debate between the role of fundamentals, asset demand and speculation in influencing oil price movements, this paper considers all explanations in trying to infer the strength of competing hypotheses. Two methodologies are used to separate out the various effects. First, a reduced form analysis introduces all the variables simultaneously with no identifying restrictions on supply and demand effects. Second, a simultaneous equation model is estimated that identifies supply and demand curves through exclusion restrictions. Both models broadly capture the surge in oil prices in 2007–08 and the subsequent fall but not the full extent of the price movements. The supply-demand model properly identifies these two loci within its identification structure and is able to capture a strong demand effect from global liquidity. However, it does not find support for a speculative motive based on the available data on contracts.

II. Modeling Oil Prices

This paper uses high frequency monthly data to assess the extent to which movements in the real oil price can be explained by supply factors (production, capacity, and geo-political risks), and real and asset demand factors (consumption of oil and inventory movements, hedge for inflation, movements in global liquidity, and risk aversion), and whether a role can be found for speculative behavior.

On the demand side, the main element driving the rise in real oil prices in recent years has been the rapid increase in oil consumption from emerging markets (Killian 2009). While the demand for oil from OECD countries has remained fairly stable at between 44–50 million barrels per day, oil demand by the large emerging markets rose by about 24 percent per annum over the 2002–08 period.[4] Indeed, among OECD countries, inventory levels have shown little upward pressure since the consumption-inventory ratio has remained fairly stable; at least until the onset of the most recent recession when it fell considerably. For OECD countries, oil consumption and inventories are used as demand variables while real oil imports (oil imports deflated by the oil price) is used for large emerging markets. Higher oil demand is projected to raise prices.

[4]This is calculated as the aggregate oil import total for China, Chile, Brazil, Indonesia, Thailand, Malaysia, Turkey, Egypt, Poland, and India deflated by the oil price. The countries were chosen based on their large oil demand relative to other emerging markets and data availability.

Demand for oil as an asset has been postulated as an explanatory factor for the surge in oil prices in 2007 and 2008. Indeed, real global liquidity and the oil price have moved positively together while a measure of riskiness or volatility (the VIX index) has moved in the opposite direction. Demand for real and financial assets rises when global liquidity rises and, since the volatility of the oil price makes it a risky asset, demand for oil falls when riskiness in an economy rises because agents liquidate their positions in risky assets in favor of secure ones (flight to quality, see Ciarlone and others (2009) for a discussion). Of course, the effects of shifts in oil asset demand should only be temporary. Over time, upward price pressures would lead to an increase in oil inventories based on the arbitrage condition between price changes and holding inventories and this accumulation would lead to downward pressure on the oil price (Hamilton, 2009).

Three variables are used to proxy asset demand: inflation expectations, the VIX risk aversion index, and global liquidity. Inflation expectations are measured as the difference between the nominal return on a U.S. government bond and the real return from an inflation indexed bond with similar characteristics (breakeven rate). Global liquidity proxies funds for investment opportunities and future consumption and is the sum of the U.S. monetary base and world international reserves. The VIX index is used to measure risk aversion and corresponds to the implied volatility of the S&P 500 index options.

Supply factors are governed by the oil production and capacity decisions of OPEC and non-OPEC countries and by geopolitical factors. World oil production has risen gradually over the past 15 years to over 85 million barrels per day at end 2008, although the level has been fairly flat since 2005. The dip in OPEC's production in 2009 reflects the decision to limit oil production in the face of low oil prices. In terms of production capacity, OPEC production averaged about 97 percent of capacity between 2005 and late 2008 when production cuts, associated with the crisis, brought the level down to 88 percent, where it stands currently. To measure oil supply, the analysis uses the ratio of production to production capacity (supply margin) for OPEC countries and production for non-OPEC countries; greater capacity constraints are expected to put upward pressure on prices.

Geopolitical risks are a well documented component of supply risk with the surges in oil prices in mid and late 1970s and 1991 associated with major geopolitical events (Yom Kippur, Iran-Iraq, and Kuwait wars). Indeed, Chen, Graham and Oswald (2008) have used the number of global terrorist attacks as an instrument for oil prices in explaining oil price effects on profit margins, suggesting that geo-political risks can explain oil movements. Interestingly, however, except for a few brief oil price surges and declines, the run-up in prices since 2002 has not been associated with a sustained increase in geopolitical risk (defined inversely, with higher values implying lower risk). The risk indicator used in this paper is provided by the International Country Risk Guide and is based on perceptions of government stability, socioeconomic conditions, the investment profile, and internal and external conflict, with greater political risks putting upward pressure on oil prices.

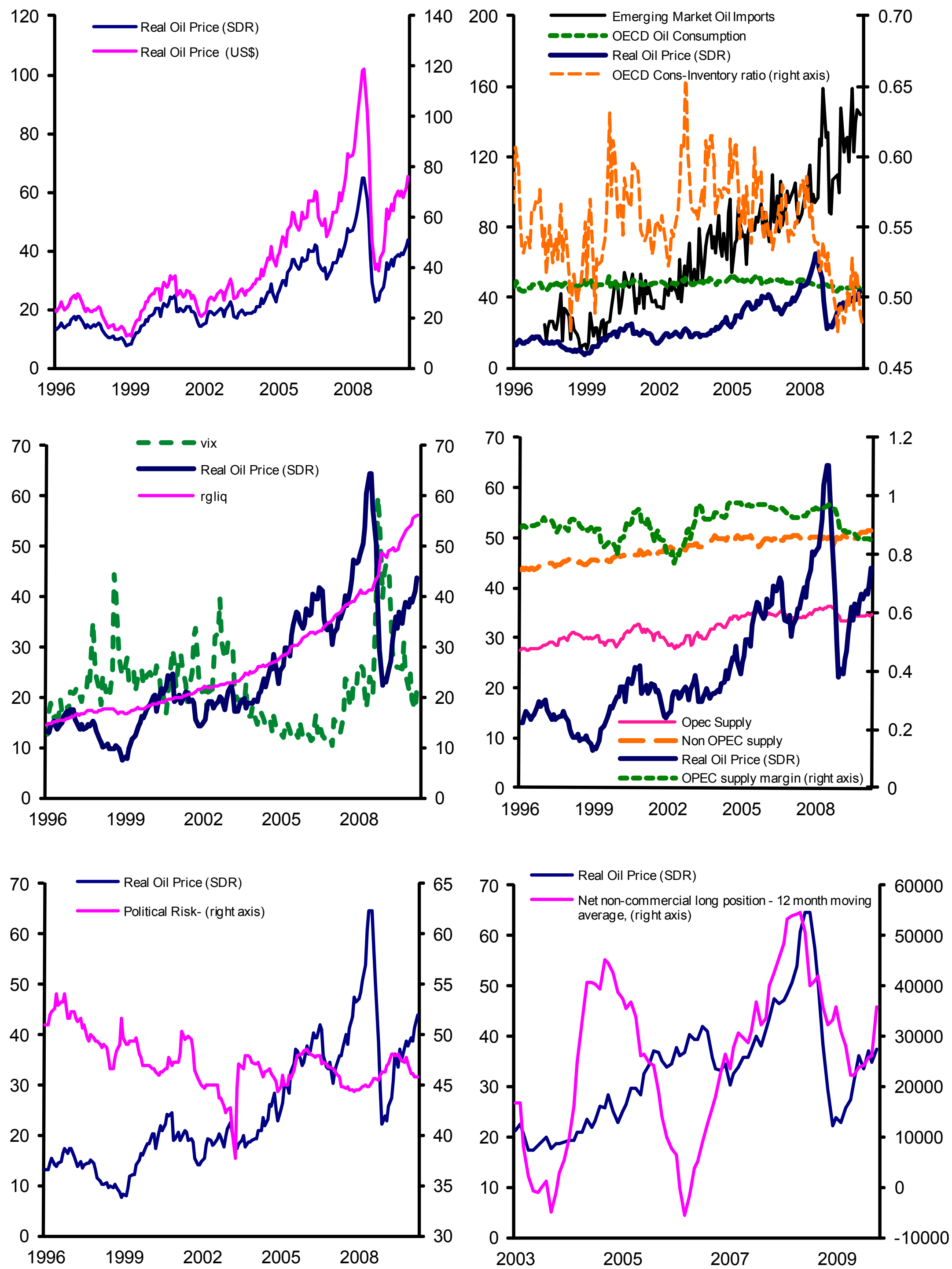
Commodities have attracted increasing financial interest in recent years demonstrated by the sharp rise in commodity assets under management. To measure the speculative component of commodity investment, this paper follows the approach adopted earlier by IMF staff, using the difference between long and short holdings of oil futures contracts by noncommercial investors as its measure. Investors are classified as noncommercial if they are not hedging an existing exposure. These data are available from trades on the New York Mercantile Exchange (NYMEX). Other exchanges, such as the International Commercial Exchange (ICE), have also captured large trade volumes in recent years but provide no data that distinguish between commercial and noncommercial trades. The NYMEX net long position is thus used as the main variable for speculative positions, with the change in ICE contracts used as a check on results. The underlying assumption is that more speculative contracts put upward pressure on oil prices in the short run.

The analysis focuses on the real oil price. Equilibrium in the market is a real concept, and nominal oil prices can clearly be influenced by aggregate price movements. Moreover, to abstract from movements in the U.S. dollar exchange rate, the real oil price is defined in terms of SDRs and deflated by a weighted average of the SDR basket deflators.

The panel charts in Figure 2 present an overview of the relationships as a precursor to the estimation results. Panel 1 presents a comparison between the real oil prices measured in SDRs versus the real oil price defined in terms of U.S. dollars. As expected the real oil price in SDRs is less volatile than the real oil price measured in dollars although the broad profiles are similar. Panels 2 and 3 compare consumption and asset demand indicators and the real oil price. Emerging market demand is able to explain the long-run upward movement in the real oil price while risk aversion is inversely correlated with the real oil price.

In terms of the supply margin, there appears to be a relationship between tightness in the supply market and the real oil price between 2002 and 2008 but the upward movement in the real oil price is difficult to explain in terms of supply variables (Panel 4). While the short-run relationship between political risk and the real oil price is weak, there appears to be an inverse long-run relationship (Panel 5). Finally, Panel 6 indicates the absence of a relationship between the real oil price and a moving average of the volume of net long noncommercial contracts over the whole recent sample period, but a strong relationship since 2007.

Figure 2. Oil Prices: Role of Fundamentals and Speculation



Sources: WEO, IFS, Datastream, Bloomberg, International Country Risk Guide, EIA and Fund Staff estimates.
Notes: Supply margin is the ratio of OPEC crude oil production to its production capacity. Political risk ranges from a high of 100 (lowest risk) to a low of 0 (highest risk).

III. A Multivariate Model

Before estimating our reduced form model, we must test for stationarity. Nonstationary variables comprise the real oil price, emerging market oil imports, non-OPEC production, political risk, the SDR/U.S. dollar exchange rate and futures contracts on the ICE exchange (Table 1).

The dependent variable is defined as change in the real oil price expressed in SDRs and the change in the U.S. dollar nominal price. The variables used as long-run determinants of the oil price capture demand (emerging market import volumes and OECD consumption) and supply considerations (non-OPEC oil production). Short-run dynamics are captured by changes in the long-run determinants and variables measuring oil supply (the change in OPEC's supply margin and its square term), asset demand (the change in global liquidity and the VIX index), political risk, and speculation (the change in net long noncommercial contracts). All variables are expressed in logarithms except for the change in net long noncommercial positions since this variable can take on positive and negative values.

Table 1. Stationarity Tests

AUGMENTED DICKEY FULLER TEST

Variable	Test Statistic	P Value
nominal oil price	-1.44	0.56
Δ nominal oil price	-7.89	0.000***
real oil price	-1.55	0.51
Δ real oil price	-6.21	0.000***
real oil price (in USD)	-1.42	0.57
Δ real oil price (in USD)	-6.05	0.000***
OECD demand margin	-2.40	0.14
Δ OECD demand margin	-3.03	0.03**
OPEC supply margin	-3.23	0.0183**
inflation expectations	-3.53	0.0072***
stock of non-commercial contract:	-4.74	0.000***
nominal global liquidity	2.79	1.00
Δ nominal global liquidity	-6.40	0.000***
real global liquidity	1.54	1.00
Δ real global liquidity	-8.77	0.000***
emerging markets oil imports	-1.40	0.58
Δ emerging markets oil imports	-9.90	0.000***
political risk	-2.33	0.16
Δ political risk	-9.84	0.000***
USD exchange rate	-2.15	0.22
Δ USD exchange rate	-8.03	0.000***
Non-OPEC oil supply	-1.95	0.31
Δ non-OPEC oil supply	-11.45	0.000***
OECD inventories	-4.82	0.000***
OECD consumption	-2.62	0.09*
Δ OECD consumption	-15.85	0.000***
VIX index	-2.74	0.0667**
5 year inflation forecast	-5.17	0.000***
Industrial production	-1.62	0.47

The econometric analysis indicates that the long-run determinants of the real oil price have the correct signs and are significant (Table 2). The coefficient on OECD consumption is much larger than the coefficient on emerging market import demand because OECD consumption has hardly moved over the past decade.[5]

[5]The inclusion of the production/capacity variable yielded a positive coefficient and was excluded as a long-run supply determinant.

Similarly, the coefficient on non-OPEC supply is high because its historical movements have been small. The corresponding error correction term is significant at conventional levels but the speed of adjustment to the long-run equilibrium is slow with a half life of just over one year.

In terms of short-term movements, changes in real oil prices are significantly influenced by supply pressures. The supply margin for OPEC countries is positive but the square of the supply margin term is significantly negative, suggesting that large changes in production relative to capacity are not fully reflected in oil prices. The change in political risk (measured inversely) is significantly positive. One possible explanation is that when perceptions of political risk are receding, countries become more willing to adopt the OPEC supply quotas, putting upward pressure on prices. The short term determinants measuring asset demand (the VIX index and the change in global liquidity) are insignificant while the change in net noncommercial contracts (capturing speculation) has the correct sign but is not significant at conventional levels.[6] There are only minor differences in coefficient estimates using the nominal oil price; the main difference being that the demand margin is significant at the 10 percent level.

Table 2. Regression Estimates: Reduced Form

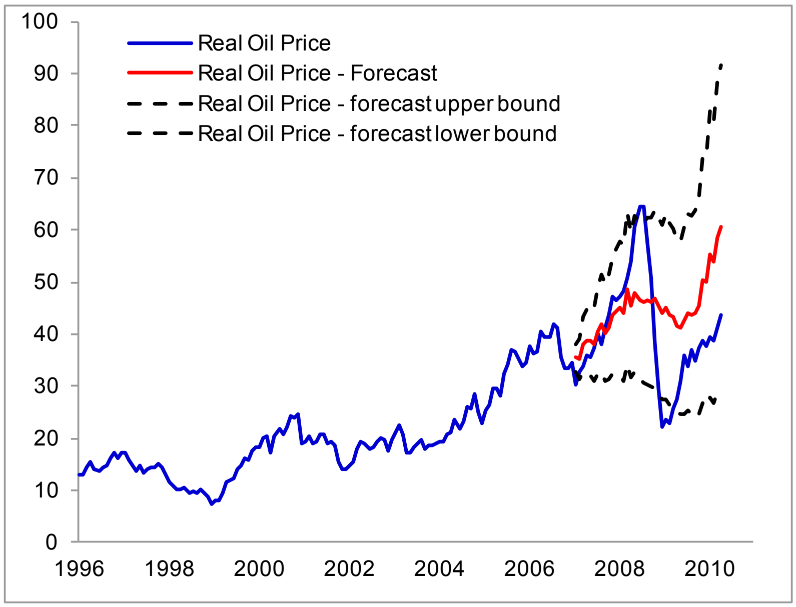
Real Oil Price Equation			
Regressors			
Δ supply margin squared (t-1)	-0.26	-2.74	***
Δ stock of non-commercial contracts (t-1)	0.25	1.01	
VIX index (t-1)	0.02	1.25	
Δ supply margin (t-1)	0.47	1.04	
Δ polrisk (t-1)	0.90	2.69	***
Δ real global liquidity (t-1)	-0.26	-0.43	
Δ emerging markets oil imports (t-1)	-0.05	-1.21	
Δ OECD consumption (t-1)	-1.06	-1.14	
Δ non-OPEC supply (t-1)	-1.08	-1.30	
Δ OECD demand margin (t-1)	0.91	1.35	
error correction (t-1)	-0.07	-1.98	**
Long run determinants			
Emerging markets oil imports (t-1)	1.46	-8.00	***
OECD consumption (t-1)	8.35	-3.85	***
Non-OPEC oil supply (t-1)	-8.78	3.85	***
LM-Stat- 2 lags (Null Hypothesis: No autocorrelation)	17.70		
Number of Observations	154		
R-squared	0.24		
Nominal Oil Price Equation			
Regressors			
Δ supply margin squared (t-1)	-0.20	-2.19	***
Δ stock of non-commercial contracts (t-1)	0.35	1.31	
VIX index (t-1)	0.02	1.12	
Δ supply margin (t-1)	0.50	1.07	
Δ polrisk (t-1)	0.90	2.57	***
Δ nominal global liquidity (t-1)	-0.09	-0.13	
Δ emerging markets oil imports (t-1)	-0.04	-0.91	
Δ OECD consumption (t-1)	-1.35	-1.41	
Δ non-OPEC supply (t-1)	-0.90	-1.05	
Δ OECD demand margin (t-1)	1.18	1.72	*
error correction (t-1)	-0.05	-1.98	**
Long run determinants			
emerging markets oil imports (t-1)	1.72	-7.11	***
OECD consumption (t-1)	8.54	-2.96	***
non-OPEC oil supply (t-1)	-9.20	3.04	***
LM-Stat- 2 lags (Null Hypothesis: No autocorrelation)	13.59		
Number of Observations	154		

A model's strength relies in its ability to track the real oil price. Using this benchmark, this empirical model does reasonably well since a dynamic forecast simulation of the model can replicate the pick-up in real oil prices in

[6]For these two variables, causation could be both ways but Granger causality tests indicate no causality from oil prices to the two variables and weak causality from inflation expectations to oil prices.

2007 but fails to capture the sharp downward movement since mid 2008 (Figure 2).[7] Some have argued that increased speculative behavior can explain the sharp changes in prices. However, even when the contemporaneous value of the change in net noncommercial positions is used as a determinant of oil prices (rather than the lag), the model fails to capture the full extent of the large changes in oil prices, although the coefficient is significantly positive.

Figure 3. Oil Price Forecasts



IV. Estimating a Supply-Demand Model

One problem with reduced form analyses is the inability to isolate demand and supply impulses separately. This drawback can be addressed by simultaneously estimating demand and supply relationships for oil, based on appropriate identifying restrictions. Separating the two curves can also help assess whether demand was a major factor in the 2008 price spike.

Structural VARs and demand and supply models have previously been used to distinguish between demand and supply influences in the oil market. Using VAR analysis, Kilian (2009) has found that aggregate demand shocks explain most of the movements in the real oil price since 2005. Dees and others (2007) have developed a quarterly demand-supply model with demand determinants based on domestic economic activity and the real price of oil and non-OPEC supply based on geological conditions and the real oil price. They find small and negative price elasticities of demand and positive supply elasticities. Krichene (2002) has

[7]This simulation is based on estimating the model up through end-2006 and simulating forward from this date.

developed a simultaneous model of oil demand and oil and gas supply and identifies a supply elasticity of 0.1.

The oil demand relationship in this paper has physical oil consumption variables (OECD oil consumption and real oil imports from emerging markets), inventory levels, commodity asset demand variables (real global liquidity and the VIX index), and speculation (change in net long commercial positions) as determinants, with the real oil price expressed as the dependent variable. The estimates are based on 3SLS with lagged values, U.S. industrial production output gap, inflation expectations and inflation forecasts used as instruments.

The relationship identifies a price elasticity of OECD consumption at about -0.32 and a slightly more inelastic demand relationship for emerging markets with a significant elasticity of -0.14 (Table 3). These estimates are comparable to some found in the economic literature. Cooper (2003) estimates long-run price elasticities that vary between zero for China and -0.6 for France. However, the elasticities are higher than those emphasized by Hamilton (2009), Dees and others (2005), and Krichene (2002). In terms of other variables, OECD inventory

Table 3. Regression Estimates: Demand and Supply Determinants

Nominal Oil Price Analysis			
Dependent variable: nominal oil price			
Regressors			
Demand Determinants			
Emerging markets oil imports	-0.11	-3.41	***
Nominal global liquidity (t-1)	0.36	6.15	***
VIX index (t-1)	-0.13	-5.10	***
OECD inventory stock	-1.40	-4.75	***
OECD consumption	-0.27	-1.08	
Nominal oil price (t-1)	0.80	19.94	***
Speculative Behaviour			
? Stock of non-commercial contracts (t-1)	-0.24	-0.44	
R-squared[1]	0.98		
S.E. of Regression			
(In percent of Mean of Dependent Variable)	2%		
Durbin-Watson stat	1.36		
Dependent variable: non-OPEC oil supply			
Regressors			
Supply Determinants			
OPEC supply margin	-0.04	-0.60	
Nominal oil price	0.47	4.40	***
Nominal oil price (t-1)	-0.41	-3.76	***
R-squared[1]	0.00		
S.E. of Regression			
(In percent of Mean of Dependent Variable)	1%		
Durbin-Watson stat	1.14		

Real Oil Price Analysis			
Dependent variable: Real oil price			
Regressors			
Demand Determinants			
Emerging markets oil imports	-0.14	-4.11	***
Real global liquidity (t-1)	0.44	6.00	***
VIX index (t-1)	-0.15	-5.10	***
OECD inventory stock	-1.36	-4.64	***
OECD consumption	-0.32	-1.30	
Real oil price (t-1)	0.84	21.99	***
Speculative Behaviour			
? Stock of non-commercial contracts (t-1)	-0.10	-0.19	
R-squared[1]	0.97		
S.E. of Regression			
(In percent of Mean of Dependent Variable)	3%		
Durbin-Watson stat	1.44		
Dependent variable: non-OPEC oil supply			
Regressors			
Supply Determinants			
OPEC supply margin	-0.02	-0.23	
Real oil price	0.57	4.37	***
Real oil price (t-1)	-0.49	-3.71	***
R-squared[1]	-0.31		
S.E. of Regression			
(In percent of Mean of Dependent Variable)	1%		
Durbin-Watson stat	1.20		

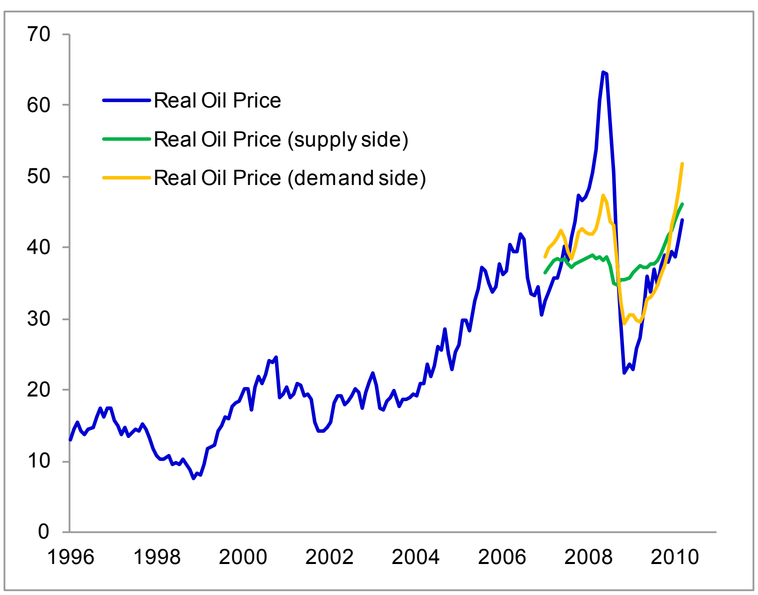
[1] R-squared estimates are not well-defined when using instrumental variables.

holdings are significantly negatively related to the real oil price with an elasticity of -1.36, consistent with Ye and others (2005), while commodity asset demand variables are significant (real global liquidity and the VIX index) in contrast to the reduced form equation, and the change in noncommercial contracts is insignificant.

The supply relationship models the oil supply of non-OPEC countries and finds that it responds positively to real oil prices with an elasticity of 0.57. This elasticity is higher than other aggregate oil supply estimates. For example, the lower supply elasticity (0.1) in Krichene (2002) could relate to the behavior of OPEC since these countries are included in his analysis. The insignificant OPEC supply margin variable indicates that non-OPEC oil supply does not respond to the level of oil supplied by OPEC countries except through the latter's effect on the real oil price.

To assess this model's ability to capture the recent, sharp oil price swings, this relationship is also estimated through 2006m12 and a dynamic out of sample forecast for the oil price is calculated through 20010m12 based on demand and supply influences.[8] The out of sample forecasts show that the demand relationship partially picks up the rise in prices in 2007–08 and the subsequent decline but cannot fully explain the run-up in oil prices nor the severity of the decline. The supply locus is below the actual outcome in 2007–08 but matches the actual outcome in recent months. This is partly related to the considerable rise in non-OPEC supply in the second half of 2009 that the model partially attributes to rising prices. Both demand and supply curves suggest that the oil price is projected to rise somewhat further in 2010.

Figure 4. Oil Price Forecast: Demand and Supply Determinants



[8]The supply equation is inverted to provide the implicit real oil price.

V. CONCLUSION

A fairly rich model of the determinants of real oil prices with simple dynamics can reasonably replicate out-of-sample developments, except for the full amplitude of price swings between late 2007 through 2009. In the reduced form model, asset demand determinants provide little explanatory power, but long-run movements in the real oil price are determined by a combination of supply (non-OPEC) and demand influences (OECD and emerging market consumption demand). In a model where they are estimated separately, price elasticities of demand and supply are comparable to those highlighted in the economic literature, yet risk attitudes and global liquidity are also found to contribute to the good fit of the model.

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