Joint Economic Committee Hearing

"Oil Bubble or New Reality: How Will Skyrocketing Oil Prices Affect the U.S. Economy?"

Wednesday, June 25, 2008

Testimony prepared by
Frederick Joutz,
Professor of Economics and Director,
Research Program on Forecasting,

The George Washington University

"Oil Bubble or New Reality:
How Will Skyrocketing Oil Prices Affect the U.S. Economy?"

Since the 1970s, macroeconomists and energy economists have viewed large changes in the price of oil as a contributing source of economic fluctuations both domestically and globally. Large increases in oil prices on their own do not lead to recessions, falling incomes, higher unemployment, and rising inflation.

There do appear to be two facts which macroeconomists and energy economists agree on. First, the perception of the negative impact on the macroeconomy appears to be weakening. Second, while oil price increases may be associated with declines in economic activity, the reverse is not true. That is sharp declines in prices do not lead to expansions in economic activity.

I hope to describe the nature of the negative relationship between large increases in oil price and the U.S. economy this morning. Also, I hope report on recent evidence on the changes in the relationship since the late 1990s.

In the post World War II era, there have been 14 significant increases in the price of oil. According the National Bureau of Economic Research (NBER) there have been 10 recessions. I have added an 11^{th} for current economic conditions. The oil price shocks have preceded the onset of the recessions by 1-5 quarters. Hamilton (1983) was the first to emphasize this possible relationship. He did not claim that oil price shocks caused recessions only that they contributed to the decline in macroeconomic activity.

Table 1
Dates of Oil Price Shocks and Recessions

(Positive) Oil Price Shocks	NBER Recession Dates
Dec-47	1948q4 (4)
Jun-53	1953q2 (4)
Feb-57	1957q3 (2)
Jan-00	1960q1 (3)
Mar-69	1969q3 (3)
Dec-70	
Jan-74	1973q4 (5)
Jul-74	
Jun-79	1980q1 (1)
Jan-81	1981q3 (4)
Aug-90	1990q2 (3)
Jun-00	2001q2 (?)
Nov-04	
Jan-07	2007q4(current)

Source: NBER and US EIA
Recession Dates: Quarter of peak and (number of quarters until trough in GDP)

In a recent study Blanchard and Gali (2007) discuss the evidence in favor of a moderation of the potential negative macroeconomic consequences following an oil price shock. Macroeconomists and energy economists have suggested that the impact of oil price shocks has been getting smaller. Their model suggests that a 10% increase in the real price of oil led to a fall in GDP of about -0.5% one year later and an increase in the CPI of about 0.5 before 1983. Since 2000 the impact of a 10% positive oil price shock appears to be -0.2% one year later and in increase in the CPI of 0.3% one year later (figure 1).

Blanchard and Gali compare the two major price increases of the 1970s with the two major price increases since 2000. I have added a third one since their period of analysis ended in December 2005. Since January 2007 the effective increase in the oil price has been double the earlier episodes. A major price increase is defined as a rise of more than 50%. These five significant oil shock episodes are described in Table 2 below.

Table 2
Major Post WWII Oil Price Shock Episodes

Episode	Run-up period	50% rise date	Cumulative log change in $	Cumulative real log change in $
E1	1973q3-1974q1	1974q1	104%	96%
E2	1979q1-1980q2	1979q3	98%	85%
E3	1999q1-2000q4	1999q3	91%	87%
E4	2002q1-2005q3	2003q1	113%	104%
E5	2007q1-present	2007q4	205%	207%

Note: episode 5 is based on author's preliminary estimates and is based on 17 months of data.

The impact of these oil price shocks on macroeconomic activity for industrialized countries and the change in effect across episodes can be illustrated in the tables 3 below. Again, these are summarized from Blanchard and Gali.

Table 3

Oil Price Shock Episodes and the Cumulative Impact on GDP Growth

	E1	E2	E3	E4	E5	Avg(E1,E2)	Avg(E3, E4)
U.S.	-13.3	-11.8	-3.7	7.1	-1.8	-12.5	1.7
Euro12	-9.1	-2.9	1.0	-0.4	-1.4	-6.0	0.3
Japan	-16.1	-4.4	7.6	3.3	-1.0	-10.3	5.4

Oil Price Shock Episodes and the Change in Inflation

	E1	E2	E3	E4	E5	Avg(E1,E2)	Avg(E3, E4)
U.S.	4.9	4.0	1.7	-0.2	1.2	3.3	0.7
Euro12	4.3	2.7	1.3	-0.5	0.6	3.5	0.4
Japan	7.9	1.0	-1.7	0.9	0.6	4.4	-0.4

Note: episode 5 is based on author's preliminary estimates and is based on only 5 quarters of data.

The average impact on GDP growth and inflation was much larger in episodes 1 and 2 compared with the episodes 3 and 4. The cumulative impact on GDP growth was positive in the last two episodes and the impact on inflation was about one-fifth. However, in the most recent episode, E5, we observe that there has been a cumulative decline in GDP growth of almost 2% and increase in inflation of 1.2%. The current period of stagflation,

recession with inflation, while not over is consistent with the earlier episodes from the 1970s, but not as large quantitatively.

The most recent episode appears to suggest that large oil price increase and macroeconomic stagflation relationship has returned, but not as strong. Prior to the current episode, there have been four major hypotheses or explanations for the break down of the relationship.

The first argues that the impacts of oil prices on the economy are actually similar. But when combined with other negative shocks there appeared to be a stronger effect in the 1970s than warranted. Too much of the blame for economic downturns was attributed to oil price shocks.

The second explanation involves structural change in the economies. Labor markets have more flexible since the 1970s. (This may apply to other input markets for production.) This manifests itself through a decrease in real wage rigidities over time. When real wages are rigid, essentially fixed or not falling, there is a tradeoff between stabilization of inflation and the deviation of GDP from a full employment level of GDP or its natural level. There is a larger response in the economy to adverse supply shocks like increases in oil prices; inflation increases are bigger, output declines or slows down by more, and unemployment rises by more. If labor markets have become more flexible over time, the responses of inflation, output, and unemployment become smaller.

A third explanation involves the practice of monetary policy. In the two earlier episodes with the exception of Japan the central banks in OECD countries chose to use expansionary policy in response to the adverse supply shocks leading to higher inflation and little positive effect on the macroeconomic activity like GDP and unemployment. More recently, central banks like the Federal Reserve Board have chosen to make a stronger "pledge" to price or inflation targeting. This change in commitment and the credibility or expectation of follow through by the public may have contributed to the decline in negative effects of adverse supply shocks.

The final explanation argues that the energy intensity of GDP or production has fallen sufficiently to reduce the impact of oil price shocks. There has been a decline in the use of energy per unit of output. Modern economies have become more efficient in their consumption of energy. Thus large oil price increases do not have the same effects as before.

However, until the most recent episode, E5, these arguments may have had value in combination. But, over the past six months, macroeconomists and energy economists have argued that the large oil price increases, 200% since January 2007, have crossed a "threshold"[1] leading to a return in the stagflation result.

[1] There is no measure of the threshold. It is a concept related to the world oil market conditions.

The “threshold effect is not inconsistent with the four explanation. The macroeconomic response is smaller than before. It just takes larger oil price shocks to create negative impacts.

I address three of the energy specific facts. First, we will consider the energy intensity or efficiency issue. Then, we can discuss the recent increase in oil prices. Finally, we can look at the role of spending on oil and economic growth.

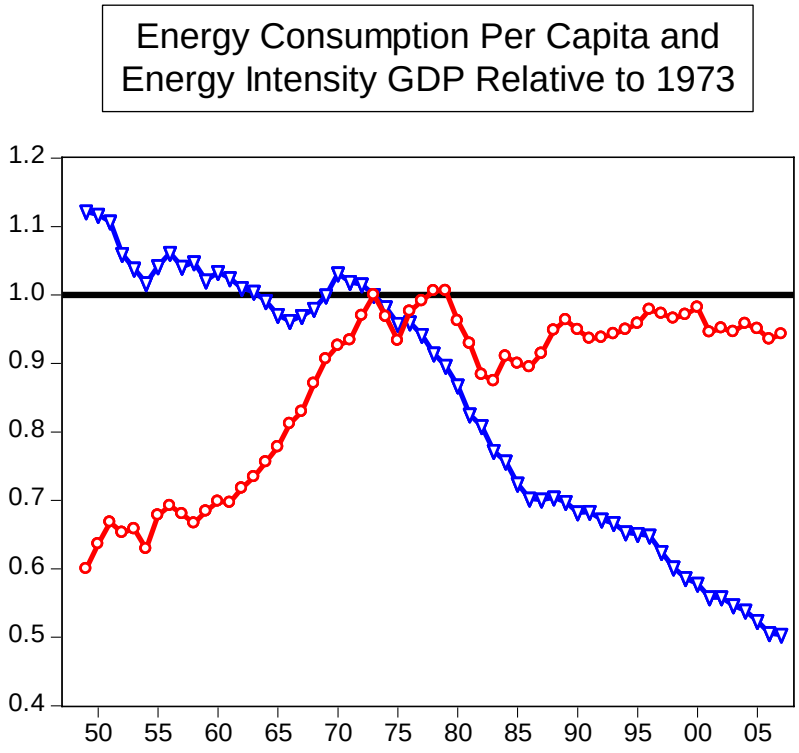
Energy Intensity or Efficiency

The US economy uses less oil (energy) per dollar of GDP in 2007 than it did in 1973. US consumers and firms have become more efficient in energy consumption. See figure 1. Relative to 1973, the quantity of energy used per dollar of GDP has fallen 50%.

However, since 1973 energy consumption per capita has stayed the same. Americans use the same amount of energy per person. It is just that technological change and conservation has allowed us to have a higher standard of living when it comes to energy.

Note, that in the 1950s we consumed one-third the amount of energy per person than we do in 2008 and about twenty-five percent more than in 1965.

Figure 1.



What has happened to the price of oil?

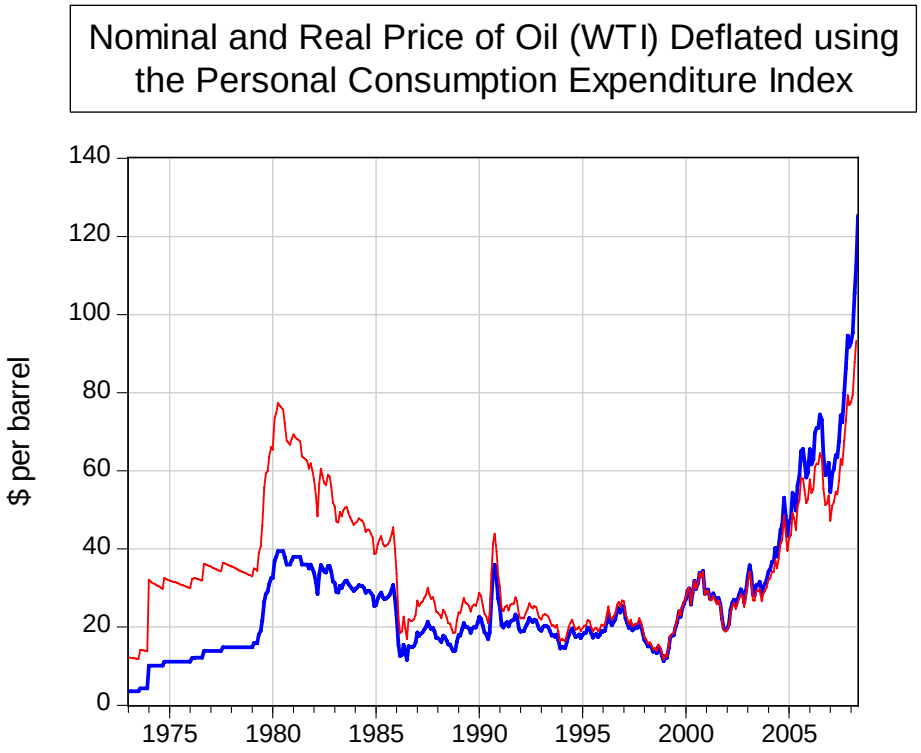
Oil prices have ranged between $10 / barrel and $135 / barrel since 1973. The first dramatic increase occurred at the end of that year associated with the Yom Kippur War. Prices more than doubled. Prices were stable about 1979 and the second major oil price shock when they more than doubled again to nearly $80 / dollars per barrel. Between 1985 and 2000, the nominal and real price of oil hovered at about $20 / barrel.

The real price of a barrel today is slightly higher than it was at its peak in 1980. It is about $79 / barrel in June of 2008 compared with $78 / barrel in March of 1980.

This is despite the fact that prices in general have risen 140% since 1980 using the personal consumption expenditure chain weighted deflator with 2000 as the base year.

Since then nominal price has risen more than 6-fold and the real price has increased more than 4-fold. Compared to the 1970s the oil price increases have been almost continuously upward. Whereas in the 1970s, the oil price increases happened relatively quickly.

Figure 2



Note: The nominal or current price is in blue and the real price is in red.

What has happened to the price of oil? (continued)

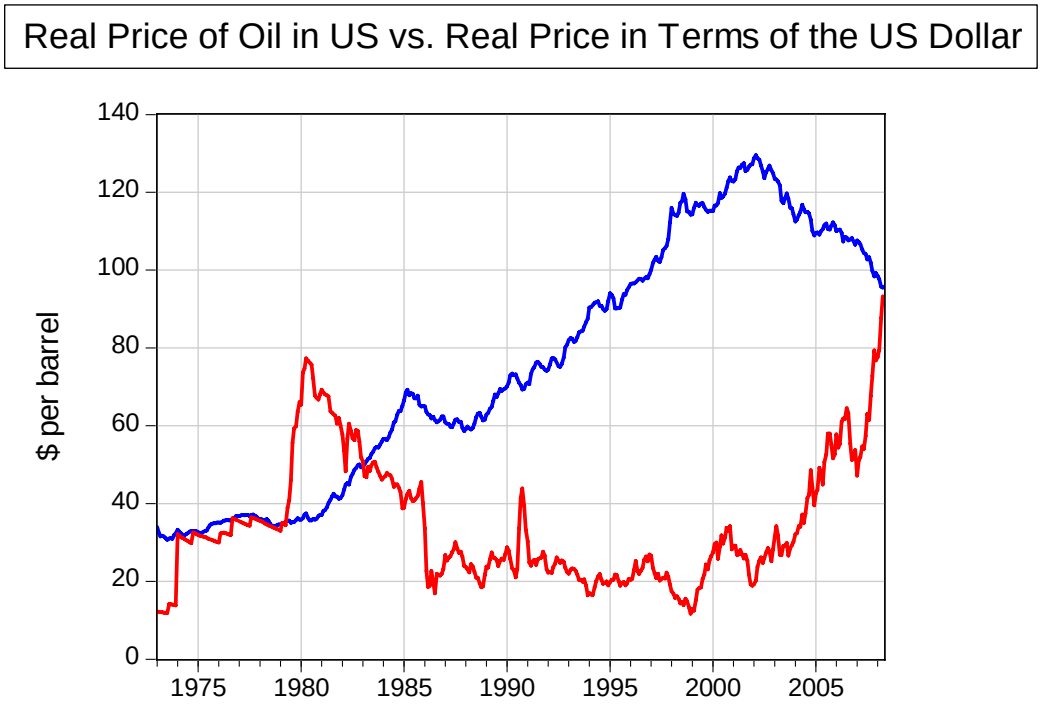
Since 2000 the real price[2] of oil per barrel has increased almost than 5-fold, from about $20 / barrel to nearly $100 / barrel.

Between 1985 and 2000 the real price of oil in the US hovered at about $20 / barrel.

However, the real price of oil has moved radically different when accounting for exchange rate movements. Between 1985 and 2000, the value of a US dollar on a trade weighted basis more than doubled. In effect, foreign importers of oil faced real price increases during this time. Similarly, the purchasing power of revenues per barrel declined for oil exporting countries by 50%.

The roles have reversed since 2002. The value of US dollar has depreciated; on a trade weighted basis it has declined by 25%. At about $100-$110 / barrel, the price is about the same for all consumers in the world.

Figure 3.



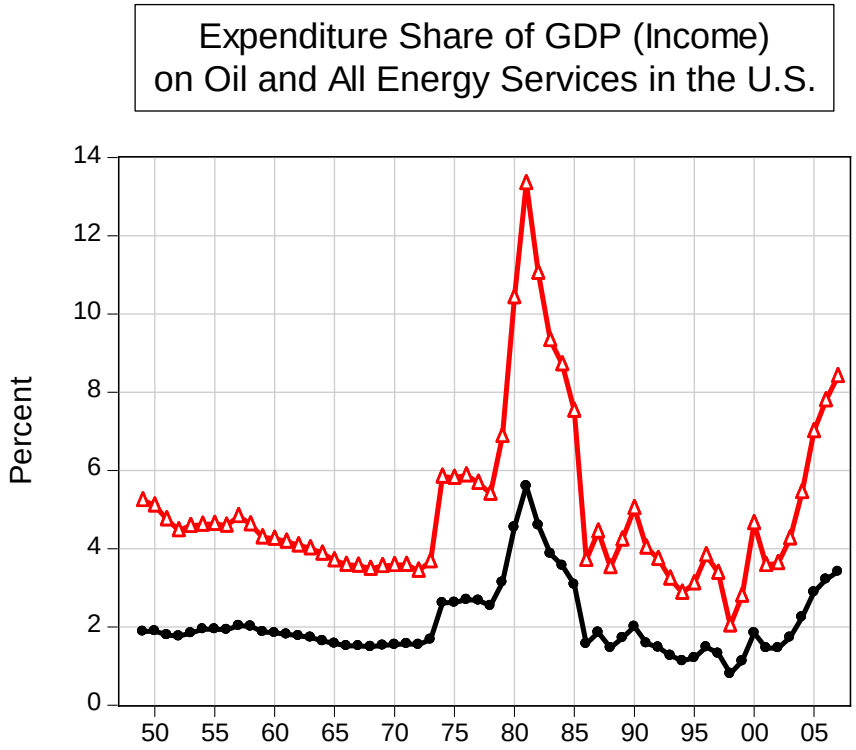
[2] The dollar price of a barrel of oil is deflated by the personal consumption expenditure chain weighted index in 2000. The real price in terms of the US dollar deflates the dollar price by international trade weighted measure of the dollar against foreign currencies.

A Look at Spending on Oil and Energy

The share of GDP spent on oil and on all energy has been about 2% and 4% respectively on average between 1950 and 2000. However, the first two major oil price episodes led to an increase in the expenditure share of both ultimately to 6% and 12% respectively. Between 1985 and 1998 the expenditure share was about 2% and 4% respectively for oil and all energy.

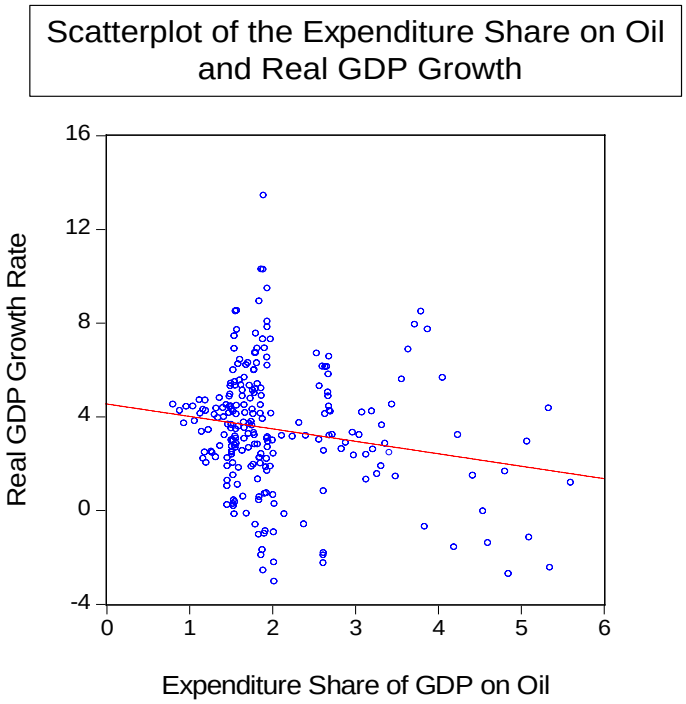
Currently the expenditure share of GDP on oil and energy is rising to the heights seen in 1980. Since 1998, the expenditure share of GDP for oil has more than tripled. This is attributed to higher oil prices. Since 1998, the expenditure share of GDP for all energy has quadrupled. This is due to a relative increase in the consumption of other energy sources and price increases in energy supplies across the board for natural gas and electricity.

Figure 4.



A Look at Spending on Oil and Energy

There appears to a simple negative relationship between how much is spent on petroleum products relative to income and real GDP growth. In a simple correlation sense it is -0.18. When expenditures to income are above average real GDP growth tends to be below average.



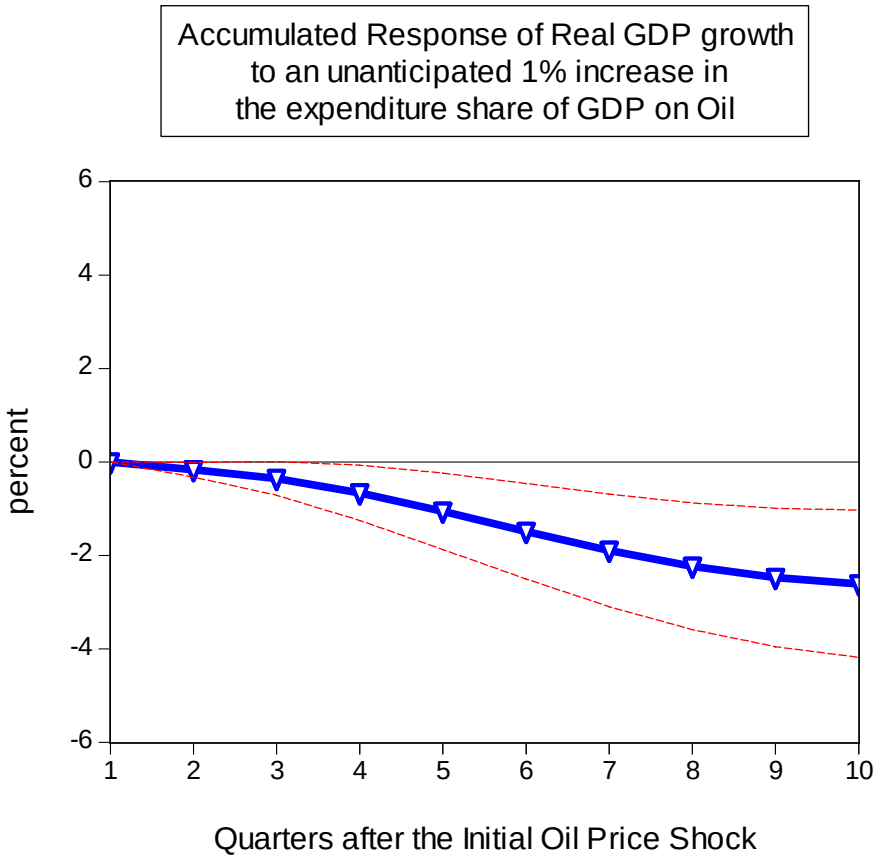
The scatter plot above does not take into account the dynamic relationship between the two measures. I estimate a simple bi-variate vector autoregression[3] using the expenditure share of GDP (income) on the growth rate of real GDP for the period 1950q4 through 2007q4. Table A.1presents the estimation results. Vector autoregressions are popular in applied macroeconomic research to learn about the dynamic interrelations between economic variables like oil prices, GDP growth, inflation, and employment. These models have contributed to our understanding of the interactions among macroeconomic variables. They permit macroeconomists to test for whether the past behavior of one series is a useful indicator in predicting future movements in other series through block exogeneity or Granger "causality" tests.

I found that past values of the expenditure share of GDP on oil helped to explain future growth rates of real GDP. The reverse was not true. Past values of economic growth do not help to explain the future budget share spent on oil. See Table A.2. In addition, I find

[3] The econometric models were estimated with a constant and 4 lags of each variable. Similar results are obtained with only 2 lags.

evidence similar to Blanchard and Gali. The impact appears to have diminished since 1983.

Another useful tool of the vector autoregression technique is the analysis of shocks of one variable on the future movements of other variables. These are sometimes referred to as structural vector autoregression models. The figure below illustrates the responsiveness of the real GDP growth rate following a one percent increase in the budget share of GDP spent on oil.



There is no immediate impact of the higher oil price. It takes about a year (4 quarters) for the impact to be significant and it continues through about 10 quarters.

Appendix A.

Results from the Vector Autoregression Model.

Other Estimates

Percentage Impact of a $10 Increase in the Price of Oil on Baseline Macroeconomic Projections

	Global Insight	U.S. Federal Reserve
	First Year	
Real GDP Growth	-0.3	-0.2
Inflation (GDP Deflator)	0.2	0.3
Unemployment Rate	0.1	0.1
	Second Year	
Real GDP Growth	-0.6	-0.4
Inflation (GDP Deflator)	0.5	0.3
Unemployment Rate	0.2	0.2

Source: EIA – 0383(2006)

Differences in U.S. Oil Price-GDP Elasticities to Higher Oil Prices and Oil Price Shocks

	Oil Price Increase	Oil Price Shock
	First Year	
Real GDP Growth	-0.011	-0.024
Inflation (GDP Deflator)	0.007	0.019
Unemployment Rate	0.004	0.009
	Second Year	
Real GDP Growth	-0.021	-0.05
Inflation (GDP Deflator)	0.017	0.034
Unemployment Rate	0.007	0.02

Source: EIA -0383(2006)

Do Adverse Oil Price Shocks Cause Recessions?

Let's begin our analysis by:

Looking at the issue from a micro perspective,

Considering a general equilibrium approach, and

Examining several short-run macro-models.

•

The Role of Energy in Production

Energy resources are an important input in the production of goods and services.

Consequently an increase in the price of energy will:

1. Raise total costs of an efficient producer's output
2. Alter the most efficient means of production
3. Lower the profit maximizing level of output
4. Raise the long-run equilibrium level of output
5. Cut the productive capacity of each firm's existing stock of capital

Capacity output declines because:

1. Higher energy prices reduce the quantity demanded of energy and energy using capital stock
2. Some capital becomes obsolete
3. Substitution towards labor and capital is not perfect 1:1

Changes in Firm Capacity affect the economy's natural rate of output and long-run aggregate supply
Energy Prices can have direct and indirect effects on production
Consider a 3-factor production function (Bohi, 1992)

(1) Q = F(K, L, E)

– Where Q is gross output

K is real capital inputs
L is labor inputs (hours)
E is energy inputs
Net Output is given by

(2) Y = Q - PeE

Where Pe is the relative price of energy (output is the numeraire)
Substitute the gross output equation (1) into net output (2)
Assume that the marginal product of each input is equal to the price

dF(.) / dK = R
dF(.) / dL = W

dF(.) / dE = Pe

Convert to natural logarithms
Take the derivative with respect to the price of energy

$$\frac{d \ln Y}{d \ln Pe} = \left[\frac{RK}{Y}\right]\frac{d \ln K}{d \ln Pe} + \left[\frac{WL}{Y}\right]\frac{d \ln L}{d \ln Pe} - \left[\frac{PeE}{Y}\right]$$

The impact of energy prices can be decomposed into three terms.
The last term captures the direct effect
The first two terms capture indirect effects
The effects are determined by the cost share of each in production and the substitution effect on the inputs of the production technology

The last term captures the direct effect
Net output will fall in relation to energy's cost share
This is equal to the additional resources necessary to pay for the (intermediate) energy inputs.

Net output will fall whether the additional costs are for domestic energy resources or the purchase of imports.
The first two terms capture indirect effects
These reflect the capital-energy and labor-energy substitution effects.
We need to distinguish between the short-run and long-run
In the long-run, we typically assume that inputs can be substituted for one another.
The short-run impacts are subject to theoretical and empirical debate

Capital-Energy substitution is often argued to negative by the *Capital Obsolescence Hypothesis*.

Part of the capital stock is rendered economically obsolete following an energy price shock.

This causes a decline in the flow of capital services and a decline in productivity and output.
Labor-Energy substitution is often argued to negative by the *Sticky Wage Hypothesis*.

Labor markets are inefficient and do not clear.

Rigid or sticky wages force employers to cut the demand for labor following an energy price shock.

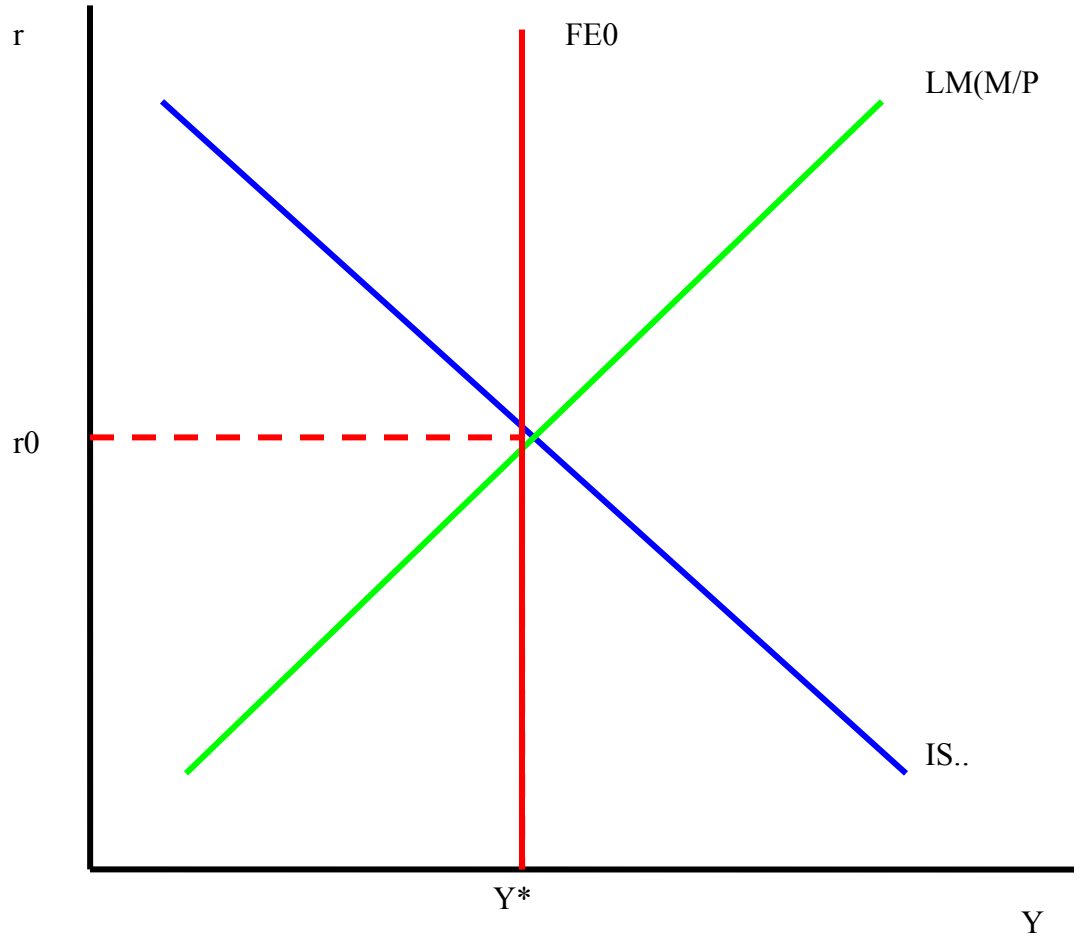
This causes a decline in the hours of labor services and a decline in output.

Use a general equilibrium framework for the complete IS-LM model

Combine labor markets, goods market and asset market equilibrium

General equilibrium occurs where the FE and IS curves intersect

Adjustments in the price level shift the LM curve to intersect where FE=IS



A Temporary Adverse Supply Shock

What is the impact of an unexpected increase in the price of energy on: output Y, the real wage W/P, the real interest rate r, employment L, unemployment UE, the price level P, the inflation rate π, consumption C, and investment expenditures I?

Define the production function as $Y = AF(K,L,E)$

If $Pe\Uparrow \Rightarrow A\Downarrow \Rightarrow MPL\Downarrow \Rightarrow L^{d}\Downarrow$

> Assume that the shock is temporary; there is no effect on consumers' wealth or expectations about the real wage.

When $L^{d}\Downarrow \Rightarrow W/P\Downarrow \Rightarrow L\Downarrow \Rightarrow L^{*}\Downarrow \Rightarrow Y^{*}(FE)\Downarrow$
$K\Downarrow$
The natural rate or full employment line shifts to the left

Again the temporary assumption is that there is no effect on expected wealth, expected output, and the marginal product of capital

As FE shifts back we are moving along the IS curve

At the same time the shock has caused the inflation rate to increase
$\pi\Uparrow \Rightarrow P\Uparrow$ until the price shock begins to stabilize, then the inflation rate slows down
Energy Prices, the aggregate price level, and the inflation rate

Energy prices are direct component of the PPI and the CPI.

However, changes in energy prices feed into other producer and consumer prices indirectly.

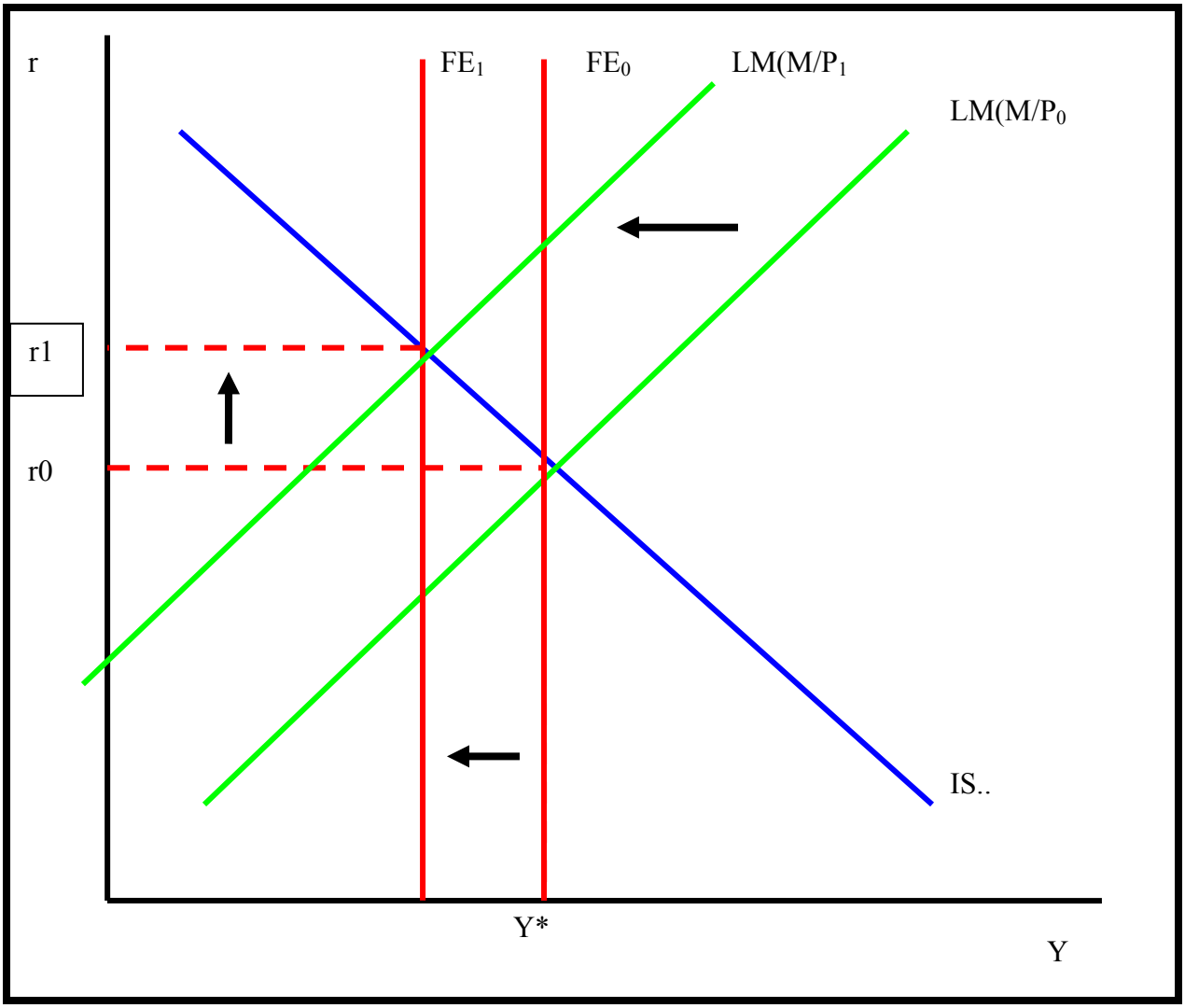
Core or headline inflation represents inflation excluding energy prices (and sometimes food)

When $P\Uparrow \Rightarrow$ real money supply falls, $M/P\Downarrow \Rightarrow$ the LM $\Downarrow$ or shifts left $\Rightarrow$ putting upward pressure on the (real) interest rate $r\Uparrow$

At the same time the shock has caused the inflation rate to increase

$\pi\Uparrow \Rightarrow P\Uparrow$ until the price shock begins to stabilize, then the inflation rate slows down and aggregate prices level off

$\Rightarrow$Output falls $Y\Downarrow \Rightarrow$ Consumption $\Downarrow$ and Investment expenditures $\Downarrow$


r
FE1
FE0
LM(M/P1
LM(M/P0
r1
r0
IS..
Y*
Y

Equilibrium in the AD-AS Model

Derive Aggregate Demand from IS-LM framework

IS: $Y = Y(r(i); G, T, Y^e, MPK^e, W^e)$

LM: $M/P = YL(i)$

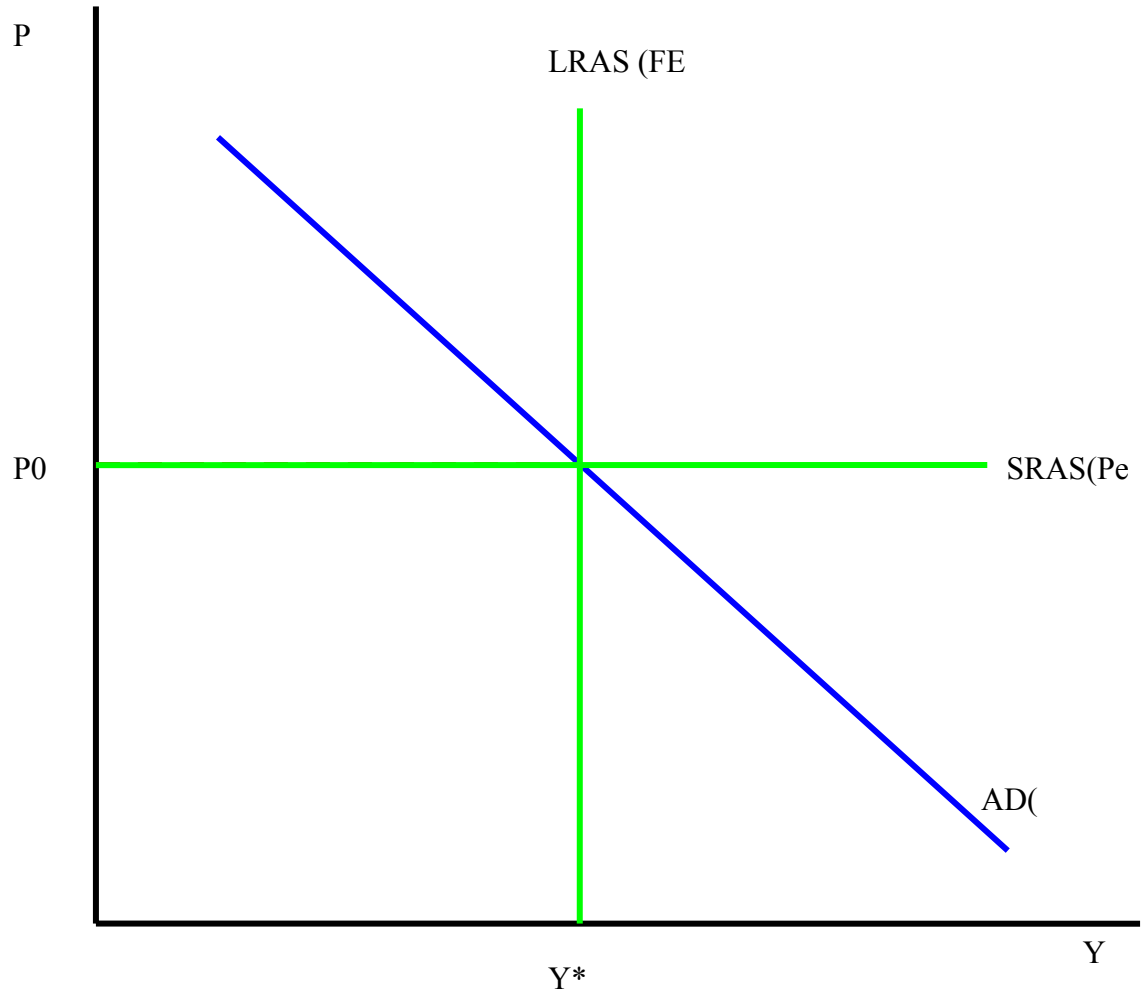
AD: $Y = Y^d(P; G, T, M, i, r, \pi, Y^e)$

Aggregate Supply

$Y = AF(K, L, E)$

Short Run Aggregate Supply

$SRAS = Ys(P; P^e, W, Pe)$



Stagflation

Term coined by Paul Samuelson in 1974.

Adverse Aggregate Supply shock

Joint observation of increasing inflation and unemployment.

Counter to the basic Phillip's Curve concept relating UE and π

Many Economist ignored conditioning the relationship on other economic factors.