

# Energy and the U.S. Macro Economy

Wilmington Club  
Wilmington, Delaware  
July 24, 2007

I am sure that over the past several years everyone in the audience has experienced “sticker shock” as the price of a gallon of gasoline at your weekly fill-up rose from around \$1.40 to \$2 and now to around \$3. More abstractly, you have read newspaper reports that the price of a barrel of crude oil rose from about \$25 per barrel to \$50 and, most recently, to the neighborhood of \$75.

Although economists are a bit nervous about this situation, the U.S. economy has performed well despite the oil price increases. We are nervous because those of us of a certain age remember well how different the situation was in the 1970s. As oil prices rose in 1973-74, the overall rate of inflation reached 11 percent over the four quarters of 1974, as measured by the price index for personal consumption expenditures. The PCE price index, by the way, is somewhat broader than the more familiar Consumer Price Index. The recession that occurred at the same time took the unemployment rate to 9 percent in May 1975.

Then it happened again. With large oil price increases in 1978-79, the PCE price index rose by 10 percent over the four quarters of 1979. There was a recession in 1980 and a more serious recession during 1981-82 that took the unemployment rate to almost 11 percent at the end of 1982.

Oil price increases over the past several years are, in percentage terms, roughly comparable to the 1970s' episodes, but overall inflation has remained relatively contained. Unemployment has drifted down and is currently about 4½ percent. This unemployment rate is at or perhaps even a bit below estimates of the full-employment rate of unemployment.

What is different this time? That is my topic this evening.

Before proceeding, I want to emphasize that the views I express here are mine and do not necessarily reflect official positions of the Federal Reserve System. I thank my colleagues at the Federal Reserve Bank of St. Louis for their comments. Robert H. Rasche, senior vice president and director of research, provided special assistance. I retain full responsibility for errors.

## SOME ENERGY FACTS

While petroleum price developments are most prominent in everyone's mind, they reflect only part of the energy story. About 40 percent of energy consumption in the U.S. economy is derived from petroleum-based products. Coal and coal derivatives are the source of about 23 percent of U.S. energy consumption; natural gas about 22 percent and the nuclear and renewable energy sources the remaining 15 percent. These sources of energy consumption have been remarkably stable over the past 20 years, as shown in Figure 1. Figure 2 shows the prices of three primary energy sources as index numbers with 1982-84 = 1.0. Figure 3 shows the prices of two consumer energy products, electricity and gasoline, again as index numbers relative to the same base period. These figures are drawn from annual average data and therefore do not show price volatility over the course of a year.

From these figures, you can see that price trends for the various energy sources have been broadly similar, except for recent years. The stability of the fraction of energy consumption from

## ECONOMIC FLUCTUATIONS

different sources is not surprising given that, until recently, price trends for these energy goods were broadly similar which means that the *relative* prices of energy sources haven't changed much. Indeed, from the mid-1980s through about 2002, the relative prices of these energy sources were almost constant. From 1980 to 2000, primary energy prices generally trended slightly downward, while the prices of the two retail energy products shown in Figure 3 were roughly constant.

It is only in the past few years that there has been a major change in the relative prices. Crude oil prices have risen most rapidly in the recent past, roughly doubling since 2000. Natural gas prices and retail gasoline prices have gone up about 70 percent over the same period. However, the price of coal has gone up only 40 percent, and the price of electricity only 30 percent. The latter reflects the large percentage of coal-fired generation capacity and regulation of retail electricity prices that slows the adjustment of prices at the retail level to increases in input costs.

The positive trend in crude oil and natural gas prices started well before the disruptions to production with the 2005 hurricanes in the Gulf of Mexico, domestic refinery outages and the heightened geopolitical risk in the Middle East. These supply-side events caused price spikes in the last couple of years, but the pattern of price movements since Y2K reflects strong world demand for energy as well as supply shocks. Given relatively low short-run elasticities of demand for the various sources of energy, the fractions of total energy consumption have not yet responded strongly to the recent price increases. If these relative price changes persist, we should expect the fraction of energy consumption from coal to rise and the fraction from petroleum and natural gas to fall.

The recent increases in nominal energy prices notwithstanding, energy in the United States remains quite inexpensive. This fact, surprising as it may seem, can be seen in Figures 4 and 5 where the real prices of various energy products are shown. By "real price" we mean the price of a good in terms of other goods. Figures 4 and 5 show the nominal prices from Figures 2 and 3

divided by the personal consumption price index for all items except food and energy (the so-called "core PCE price index") on a base of 1982-84 = 1.0. The real price of natural gas reached a high for the past 30 years in 2005 with the hurricane-related production disruptions. In 2006, real natural gas prices declined, but remained higher than anytime in the 1973-2004 period. The real price of crude trended down from 1982 through 1998, but increases beginning in 1999 brought the real price to just 9 percent above 1982-84 levels and roughly 20 percent below its 1981 peak.

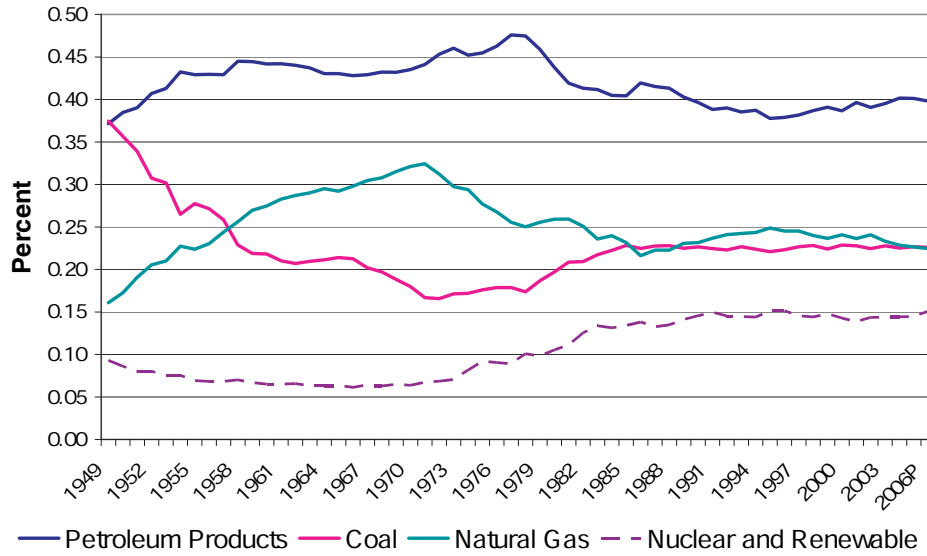
In contrast, the real price of coal fell steadily from 1976 to 2003 and has since risen only slightly. In 2006, the real price of coal was less than half of its 1982-84 value. The real retail price of gasoline has increased continuously since 2003, but in 2006 exceeded the average price of 1982-84 by only 12 percent. The relative price in 2006 is roughly 10 percent below its historical high reached in 1981. The real price of electricity fell by about 35 percent from the early 1980s until 1999, leveled off, and has increased about 12 percent since 2003. Nevertheless electricity remains 23 percent cheaper in real terms than it was on average during 1982-84.

As painful as recent energy price increases have been, this historical perspective helps us to understand why the economy has been able to absorb the price increases with little effect on the aggregate economy. Perhaps the most direct way to understand the impact of energy prices on consumers is to examine the fraction of household budgets devoted to energy.

After 1981, the share of consumer expenditures on energy out of nominal disposable personal income trended downward, from a high of over 8 percent to about 4.1 percent in 1998 (see Figure 6). Disposable personal income, by the way, is essentially all household income including transfers such as Social Security benefits less direct taxes, which are mostly income taxes. Real disposable personal income is the nominal or dollar amount adjusted for changes in the general price level.

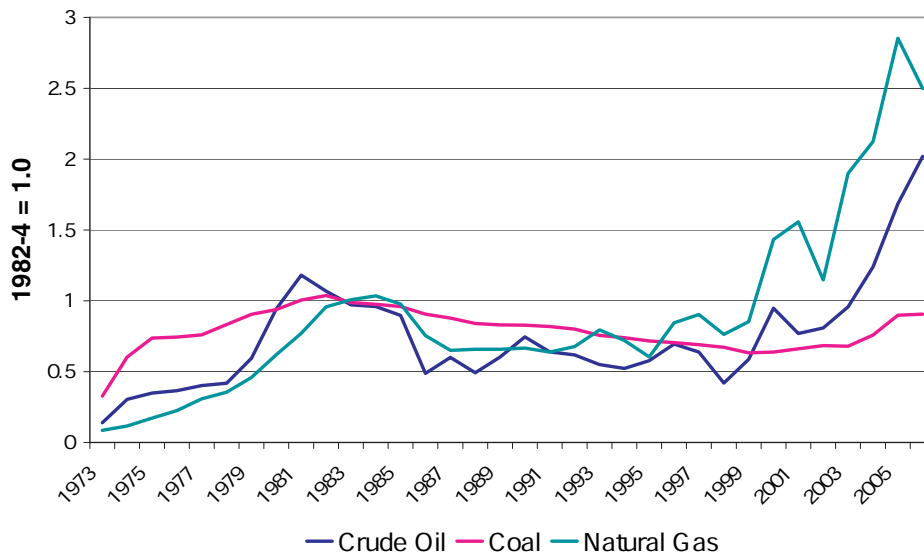
With the increase in energy prices documented in Figures 2 and 3, the energy share of disposable

**Figure 1**  
**Sources of U.S. Energy Consumption**



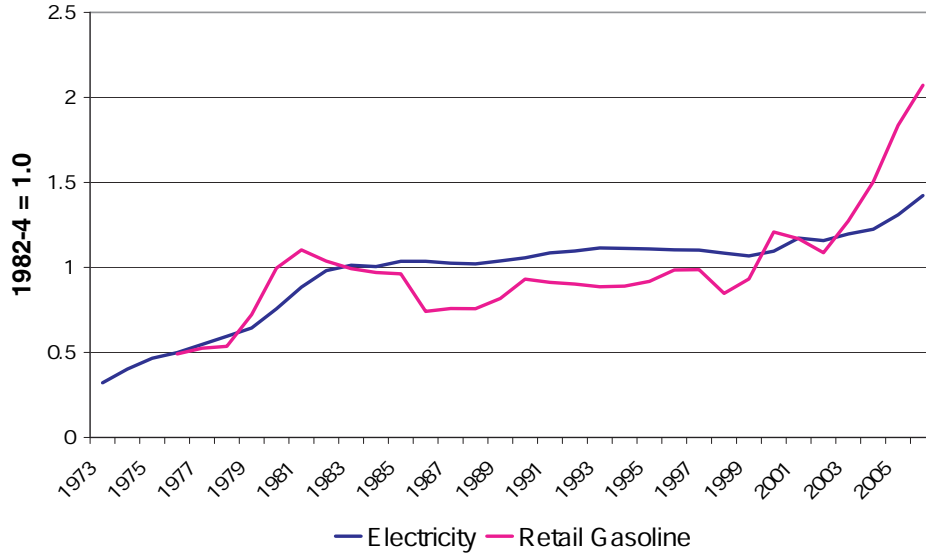
SOURCE: U.S. Department of Energy.

**Figure 2**  
**Nominal Energy Prices**



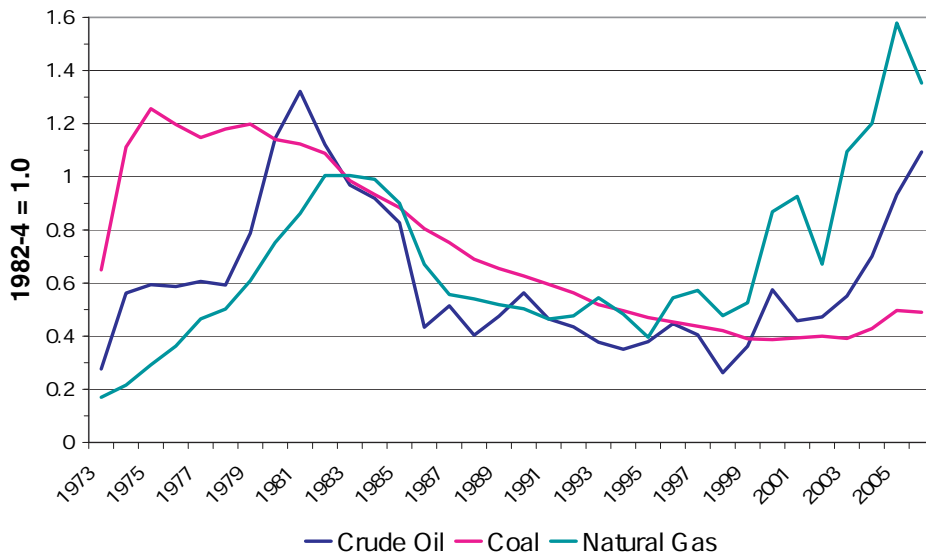
SOURCE: U.S. Department of Energy.

**Figure 3**  
**Nominal Energy Prices**



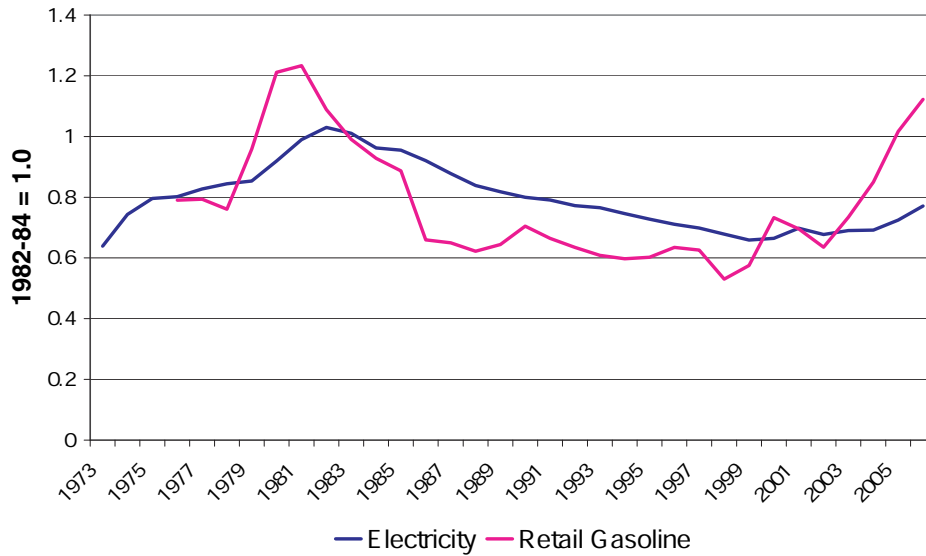
SOURCE: U.S. Department of Energy.

**Figure 4**  
**Real Energy Prices**



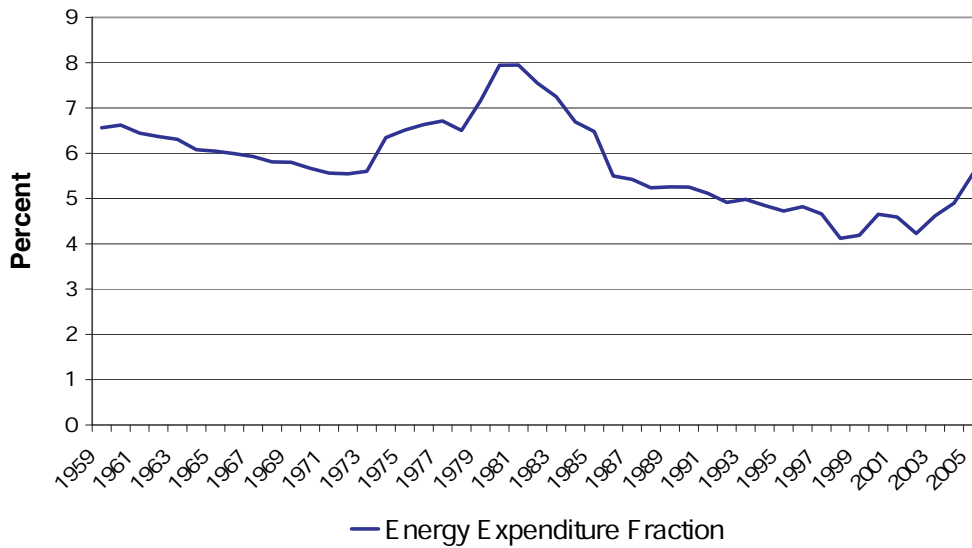
SOURCE: U.S. Department of Energy.

**Figure 5**  
**Real Energy Prices**



SOURCE: U.S. Department of Energy.

**Figure 6**  
**Share of Energy Consumption in Nominal Disposable Personal Income**



SOURCE: Computed from Bureau of Economic Analysis data.

## ECONOMIC FLUCTUATIONS

personal income rose from 4.1 percent in 1998 to almost 5.8 percent in 2006. This increase simply returns the share to about its 1985 level. It is important to recognize, however, that the increase in energy prices, though of limited impact in the aggregate, has forced difficult choices on lower-income households for whom the burden has been much higher as a proportion of income.

The recent price increases are having the expected negative impact on the quantity of energy consumed, relative to total goods and services consumed, but the total amount spent on energy has nevertheless increased. The increase in the energy share of nominal disposable personal income reflects the inelastic short-run demand for energy by consumers. Put another way, as energy prices have surged, the quantity of energy consumed has grown more slowly than real disposable personal income but not slowly enough, given the price increases, to prevent the amount spent on energy from rising significantly.

To understand the impact of energy price increases on households, we need to compare what actually happened with a baseline scenario. We'll compare 2006 with 2002. A reasonable baseline scenario assumes that the relative price of energy is unchanged—that is, that the nominal price of energy rises by the same percentage as consumer prices excluding energy actually rose. Second, let's assume that the quantity of energy consumed had increased by the same percentage that real disposable personal income actually rose. With these assumptions, the percentage of disposable income spent on energy in 2006 would have matched the percentage in 2002, which was 4.2 percent.

With these assumptions, in 2006 the baseline spending on energy in nominal dollars would have been \$400 billion. Actual spending on energy, at \$550 billion, was \$150 billion higher. Had the quantity of energy consumed increased between 2002 and 2006 at the same rate real disposable personal income increased, spending on energy in 2006 would have been higher by another \$47 billion. Thus, between 2002 and 2006, consumers' responses to energy price increases held down the increase in the quantity of energy

consumed to 1.4 percent compared to the increase in real disposable personal income of 10 percent.

I would not claim that an extra \$150 billion increase in consumer spending on energy is a small number. However, we need to put that number in perspective. The extra spending on energy in 2006 was 1.6 percent of disposable personal income. By way of comparison, consider some other spending increases between 2002 and 2006. As a percentage of disposable personal income, consumer spending on furniture and household equipment rose from 4.1 to 4.2, spending on recreation from 3.8 to 4.0, spending on food from 12.8 to 13.4 and spending on medical care from 15.4 to 16.7. Indeed, between 2002 and 2006, spending on alcoholic beverages rose by \$40 billion, from 1.5 to 1.6 percent of disposable personal income.

From these numbers, I conclude that the impact of energy price increases on consumers has been far less than headlines would lead readers and TV viewers to believe. I suppose we could argue that medical care and energy spending increases are driving people to drink, but, in the process, U.S. consumers have been able to increase their spending share on furniture and recreation as well. It must be that consumers are not so hard-pressed after all, except for those in the lowest income groups. The impact has been real, but the magnitude small enough that price increases have not disrupted the normal processes of economic growth.

## EFFECTS OF ENERGY PRICE INCREASES ON THE ECONOMY

I've emphasized that energy price increases have not had serious adverse impacts on the U.S. economy. The effects on consumers as a whole have not been all that large; the economy has grown nicely since 2002, and the labor market is currently very close to full employment. But economists do have concerns, in good part because of lingering bad memories of previous periods of sharply rising energy prices.

The energy shocks of 1973 and 1979-80 were principally supply-side disturbances to energy

markets: the OPEC oil embargo and the Iranian hostage crisis, compounded by the presence of price controls in the United States. The impact of those shocks is certainly burned into my memory, and likely into the memory of everyone who lived through experiences of long lines at gasoline stations that sometimes actually ran out of fuel; mandatory reductions in thermostat settings at business and government offices; and year-round daylight saving time. In addition, both of these shocks were followed by recession.

Over the past four years, we have seen none of the macroeconomic complications of the early energy price shocks. An important part of the difference this time is that the recent trend in relative energy prices has been driven by rapidly increasing world demand for energy. Figure 7 shows energy consumption in four major economic areas: the United States, Europe, Japan and China plus India.<sup>1</sup> The latest data available are for 2004. Between 2002 and 2004, primary world energy consumption increased 9 percent. However, energy consumption in the United States grew only 2.5 percent, in the EU-15 4.2 percent and in Japan 2.9 percent. In contrast, during this period primary energy consumption in China and India is estimated to have grown 33.0 percent. The increase in primary energy consumption in the latter two countries is estimated at 51 percent of the total world increase in energy consumption. Clearly, rapid development of populous emerging market economies is the major source of large increases in world energy demand. This shift in the world demand for energy is the underlying source of the price trends that are documented in Figures 2 to 5.

However, energy markets work! The real price increases have provoked a response in production sufficient to accommodate the higher demand. World production of primary energy increased 9.1 percent from 2002 through 2004. The price mechanism in world energy markets is alive and functioning well to increase total production

and to allocate available supply among the existing and emerging sources of demand.

Faced with these higher energy prices, consumers and businesses in the United States have reacted in the manner predicted by basic economic analysis. As I discussed above, consumers have reduced their consumption of more expensive energy relative to total consumption expenditures. Yet they have been able to maintain strong overall demand for consumption goods. Real personal consumption expenditures in the United States grew at an average annual rate of 3.5 percent from 2002 through 2006, and this strong growth in consumer demand has made a major contribution to the continued growth of our economy five years into an economic expansion.

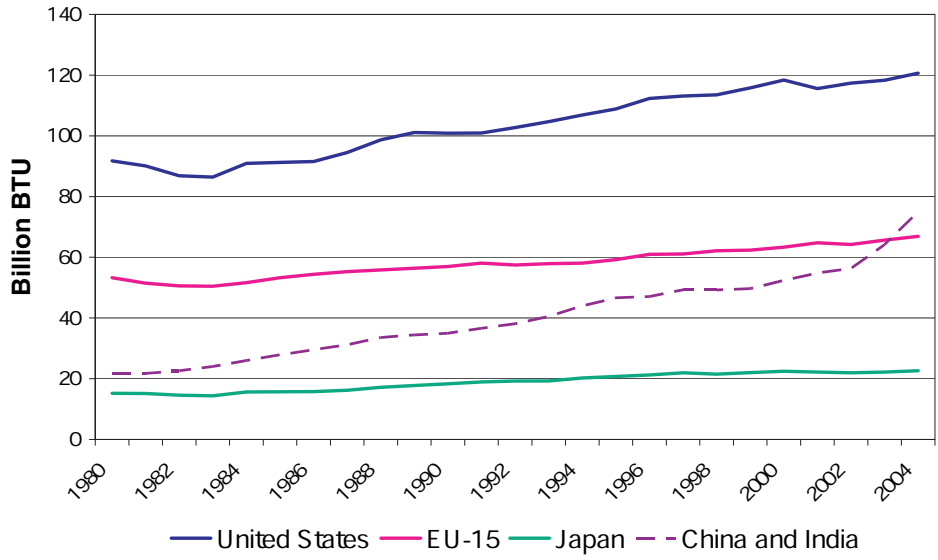
The business sector of the U.S. economy has also reacted to higher energy prices over time. Energy use per dollar of real GDP is shown in Figure 8. Energy use shows a consistent negative trend reaching a value in 2006 of 8.75 or only 48.6 percent of the 1970 value of 17.99. This downward trend is the result of efficiency improvements and structural changes in the economy that have shifted production toward less energy intensive industries. In Figure 9 it can be seen that in 2006 consumption of energy in the industrial sector—the sector consuming the most energy in our economy—is at roughly the same absolute level as it was in the early 1970s. Industrial firms have maintained this level of energy consumption even though industrial production in manufacturing in 2006 is three times larger than it was in 1970.

The transportation sector is the second largest consumer of energy in the U.S. economy. Energy usage in this sector has trended upward steadily. The increase is driven by the growing number of vehicle miles and the failure of improvements in the average fuel efficiency of the fleet of domestic motor vehicles to offset increases in total vehicle miles. Figure 10 shows fuel efficiency of various types of vehicles in the United States. Fuel efficiency of our truck fleet has been relatively constant since the late 1960s. Although substantial

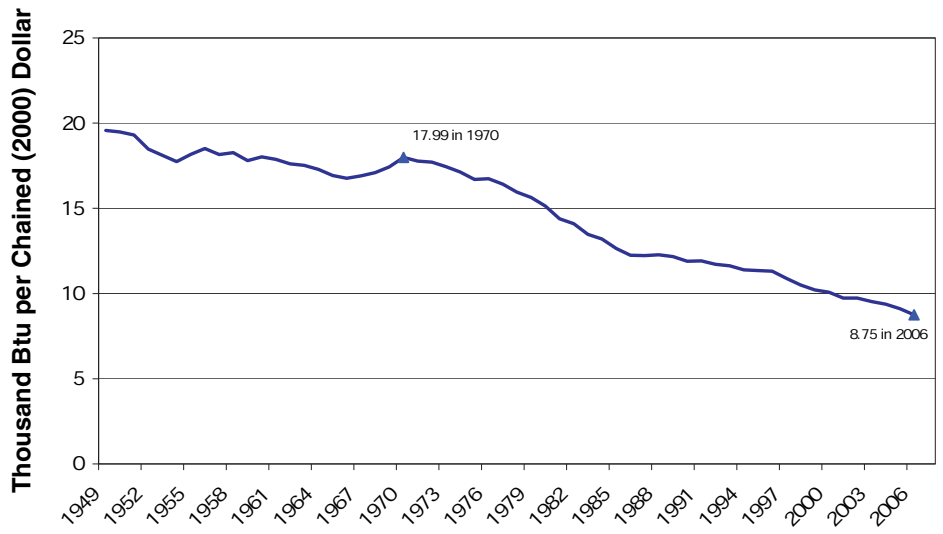
<sup>1</sup> Europe is defined here as the EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.



**Figure 7**  
**World Energy Consumption**

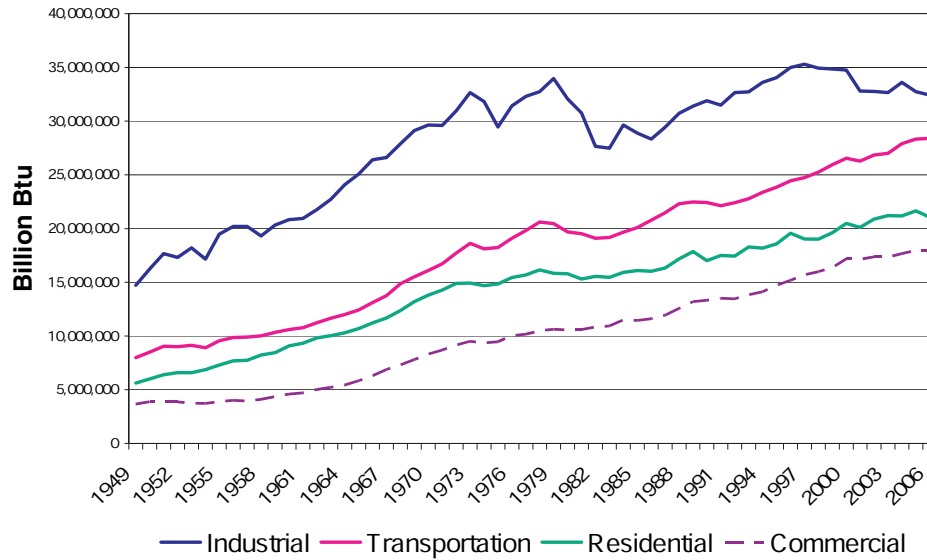


**Figure 8**  
**Energy Consumption per Dollar of Real GDP**

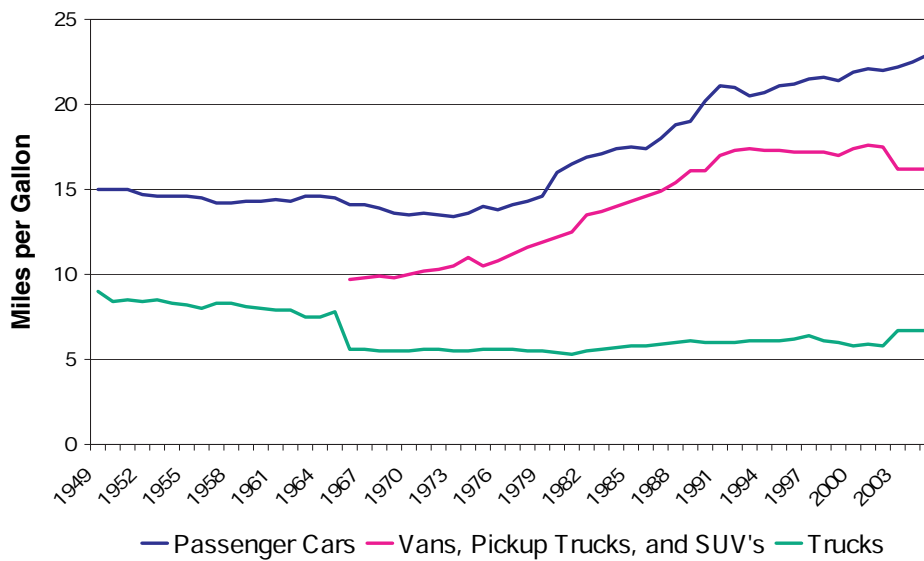


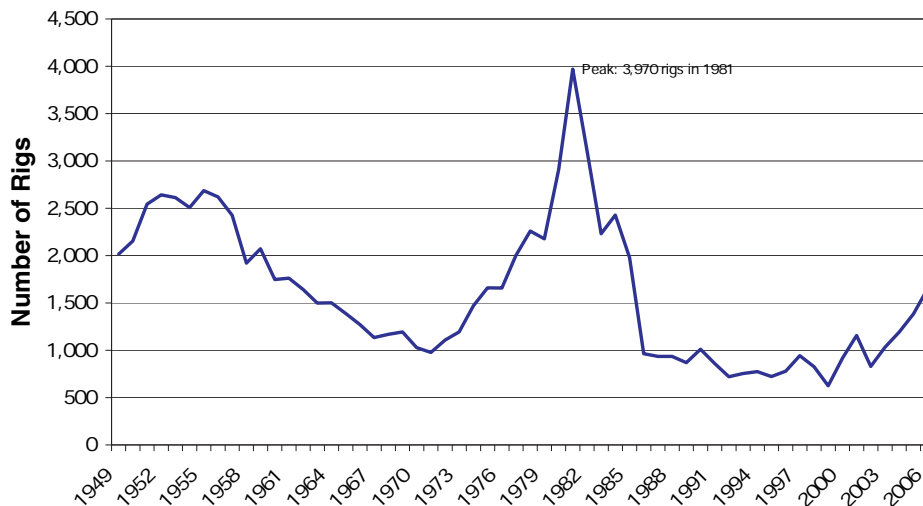


**Figure 9**  
**Energy Consumption by End-Use Sector**



**Figure 10**  
**Motor Vehicle Fuel Rates**



**Figure 11****Crude Oil and Natural Gas Rotary Rigs in Operation**

increases in the fuel efficiency of passenger cars have been realized since the mid-1970s, the fuel efficiency of vans, pickup trucks and SUVs basically flattened out or declined a bit after the early 1990s. Overall fuel efficiency has tended to decline as consumers increased the share of light trucks and reduced the share of passenger cars.

Very recently, it appears that households are adjusting their preferences for types of vehicles in light of the increased real price of gasoline. The percentage of light trucks, which includes vans and SUVs, in total light vehicle sales peaked in late 2004 at 57.5 percent and by mid-2007 had declined to 51 percent.

Residential consumption of energy leveled off from the mid-1970s through the mid-1980s but has trended up for the past 20 years. However, relative to the stock of housing in the United States, residential energy consumption has been essentially flat since the early 1980s.

Business activity is also reflecting the upward trend in relative energy prices. Domestic drilling for oil and natural gas, as measured by rigs in operation (Figure 11) has increased in the past several years, after many years of a flat level of activity. Part of the increase reflects the interaction

of new technologies and the economic incentives to exploit previously untapped and uneconomic resources. An example is the Fayetteville shale formation in Arkansas. Development of this resource requires horizontal drilling techniques and fracturing of the shale formations to release natural gas.

A second type of investment currently underway is the construction of electricity generating facilities with lower emissions. Major construction activities are underway in Kentucky and Illinois. These projects will utilize local coal resources that have been underutilized in recent years because of the availability of cheap, lower sulfur western coal. Major investments in coal generating plants have also been announced for Texas. In the longer run, “clean coal” technology in which coal is first converted to gas before burning may be introduced on a large scale.

Finally, there is a tremendous amount of investment activity in the area of alternative, non-fossil, fuels. These include numerous installations to produce ethanol from corn and factories to produce biodiesel fuels. Auto manufacturers are investing in new engine “flexfuel” technologies that will allow motor vehicles to run on dif-

ferent mixtures of fossil and non-fossil fuels. It remains to be seen whether these technologies will prove economically viable.

## CONCLUDING COMMENTS

Energy is an essential good, along with food, water, medical care and a number of other goods. However, the importance of recent energy developments is less than their high visibility leads many to believe. There are certainly strains from the high price of energy; however, there is no energy crisis, and households and firms are adjusting in a sensible way to price increases.

World energy demands are likely to continue to grow rapidly, as economic growth in China and India has developed substantial momentum. We should hope that growth will take hold in Africa and in Middle Eastern countries. If it does, rapid economic development in those areas will add further to growth in world energy demand.

Whether higher growth in the world economy will continue to push energy prices up will depend on developments in energy supply. There are many promising technologies that in time could make important contributions to energy supplies. Moreover, technology can be of enormous assistance in tempering growth in demand. To harness this technology, we need to rely primarily on market forces. Market adjustments have been the hero in preventing energy price increases over the past four years from disrupting economic growth, as happened in the 1970s. In my judgment, markets will continue to handle energy problems well, and the future for the U.S. economy is bright.