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The Disparity Between Retail Gasoline and Diesel Fuel Prices

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March 31, 2008

Abstract. This report provides background and identifies some of the likely factors and forces in world markets that may have contributed to the evolution of the relative prices of gasoline and diesel fuel over the past several years. Among these are strong international demand for diesel fuel; product mix decisions by refiners, and refinery investment to meet more stringent limits on the sulfur content of diesel fuel; the similarities between diesel fuel and home heating oil; and the effect on retail prices from local market conditions.

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The Disparity Between Retail Gasoline and Diesel Fuel Prices

Summary

Over time, gasoline has typically been more expensive than diesel fuel. However, their relative prices have now reversed. In mid-March of 2008, gasoline prices exceeded $3.39/gallon (gal) while diesel fuel prices were above $3.97/gal, a differential of almost $0.60/gal. This has prompted questions of why the historic gap between gasoline and on-highway diesel prices has widened so greatly and over such a relatively brief period of time.

Crude oil, when refined, produces a mix of products. Diesel fuel and home heating oil are derived from the portion of the barrel that produces what are termed "middle distillates." Another part of the barrel furnishes the feedstock for gasoline. Refiners process barrels of crude oil of differing quality, depending on the relative prices for oil of different qualities, and their available technology. Within technology-defined limits refiners can vary the proportions of middle distillate and gasoline production. Because the entire range of petroleum products derive from the same barrel, it is difficult to attribute general refining costs to any single product, making it also difficult to ascertain the relative cost proportions. The exception to this would be when the investment costs of changing product specifications to meet seasonal or environmental requirements can be measured.

A number of specific factors may be identified that have contributed to the shifting relative prices of gasoline and diesel fuel. It is important to recognize that the U.S. market for these fuels is part of a broader world market. World demand patterns are shifting as diesel fuel becomes a primary consumer transportation fuel in Europe and other parts of the world. World price differentials are transmitted to the U.S. market.

Other factors affecting diesel prices include refinery investment costs, as well as investment costs in the product distribution system to accommodate new specifications for diesel fuel that require lower allowable sulfur content; the seasonality of home heating oil demand, a similar product, which transmits the price effects of cold weather from the heating market to the on-highway diesel fuel market; world market effects that might affect the pricing and output mix decisions of refiners; and circumstances affecting the local market at point of purchase.

One other factor should be noted. The primary demand sectors for gasoline and diesel fuel are different in the United States. Gasoline is a mass consumer good and home heating oil an important regional and seasonal residential product, while diesel fuel is used in a wide variety of commercial and industrial applications. Diesel fuel is often part of the cost of delivering goods and providing services. As a consequence, demand for diesel fuel may be less elastic, and therefore, likelier to be passed on to consumers.

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The Disparity Between Retail Gasoline and Diesel Fuel Prices

By mid-March of 2008, gasoline prices exceeded $3.39/gallon (gal) while diesel fuel prices were $3.97/gal, a differential of almost $0.60/gal. In mid-March of 2007, the relationship between the two fuels was the reverse: gasoline prices were higher than diesel prices.[1] At that time, diesel prices were roughly $2.68/gal, while the average price of gasoline for all grades was $2.76 — more than $0.08 higher than the average price of on-highway diesel. Additionally, where gasoline prices in mid-March 2008 are roughly $0.63/gal higher than year-ago averages, diesel fuel prices have risen over $1.29/gal over the same period.[2] Over $0.60/gal of this increase has occurred since the beginning of 2008.[3] This has prompted questions of why the historic gap between gasoline and on-highway diesel prices has widened so greatly and over such a relatively brief period of time. Because diesel fuel costs affect the cost of shipping by truck, price increases affect the delivered cost of most consumer goods purchased in the United States, contributing to the over-all level of price inflation.

This report provides background and identifies some of the likely factors and forces in world markets that may have contributed to the evolution of the relative prices of gasoline and diesel fuel over the past several years. Among these are strong international demand for diesel fuel; product mix decisions by refiners, and refinery investment to meet more stringent limits on the sulfur content of diesel fuel; the similarities between diesel fuel and home heating oil; and the effect on retail prices from local market conditions.

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[1] Gasoline prices exceeded diesel fuel prices for every year between 1995 and 2004. For 2005 through 2007 diesel prices were, on average, above gasoline prices. However, the quarterly results were mixed; gasoline prices exceeded diesel prices in some quarters. See the Energy Information Administration, *Annual Energy Review 2006*, Table 5.24, and comparative gasoline and diesel price data at [http://www.eia.doe.gov].

[2] The most recent weekly prices for gasoline and diesel fuel at the pump are reported by the Energy Information Administration, Department of Energy, at these sites: [http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_home_page.html, and] [http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp].

[3] See [http://tonto.eia.doe.gov/oog/info/wohdp/List_Serve_report_All.txt].

Refining and Supply of Gasoline and Middle Distillates

A barrel of crude oil is a composite of hydrocarbons of varying densities. The initial step in refining crude oil is to separate its heavier and lighter "fractions" by heating it. The lighter products are recovered at, or near the top of a distillation column where the temperature is lowest. The heavier fractions are recovered from the bottom where the heat is greatest. Gasoline is among the lighter components. Diesel fuel and home heating oil come from the portion of the barrel that is termed "middle distillates" because the feedstock for these fuels settle out roughly in the middle of the distillation tower.

Crude oil itself is of varying densities, as well as sulfur content, generally distinguished as "light" or "heavy," or high and low quality oil. Light crude will furnish a higher percentage of lighter products than heavy crude; additional processing can increase the yield of lighter products from the heavier end of the barrel, but will add to product costs.

Once distilled, gasoline and middle distillates are further processed "downstream," where the addition of blending components and other steps create the finished petroleum products that are released to markets. The typical yields from a barrel of crude oil of gasoline and middle distillates range, respectively, around 45-47% and 25-27% depending on the time of year (see **Table 1**). Typically, refiners take some of their facilities offline for brief periods to perform maintenance and make seasonal adjustments to slightly favor the yield of gasoline or middle distillates. During the spring, refiners seek to build inventories of gasoline for the summer driving season. Conversely, production of home heating oil for the heating season is maximized beginning during the summer.

Gasoline consumption has been averaging 9.0 million barrels daily (mbd), while all distillate consumption is roughly 4.5 mbd. In 2007, U.S. imports of middle distillates averaged 348,000 b/d in 2007.[4] As is discussed later in this report, world demand for middle distillates has grown and added to the pressure on prices for middle distillate imports.

The typical product yield from a barrel of crude oil is shown in **Table 1**.

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[4] See U.S. Department of Energy. *Petroleum Supply Monthly*, Table 36. Year-To-Date Imports of Crude Oil and Petroleum Products by PAD District, January-December 2007. [http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/petroleum_supply_monthly/current/pdf/table36.pdf].

Table 1. Petroleum Products Produced from One Barrel of Oil Input to U.S. Refineries, 2006

Product	Gallons
Finished Motor Gasoline	19.30
Distillate Fuel Oil	10.70
Kero-Type Jet Fuel	3.92
Petroleum Coke	2.24
Still Gas	1.87
Residual Fuel Oil	1.68
Liquefied Refinery/Petroleum Gas	1.58
Asphalt and Road Oil	1.33
Other Oils for Feedstocks	0.53
Naptha for Feedstocks	0.51
Lubricants	0.48
Other Products and Processing Gain	3.31

Source: Energy Information Administration, Department of Energy.

As is also noted later in this report, some of the sharp runup in on-highway diesel fuel prices in recent months likely stems from the close similarity between diesel fuel and residential home heating oil. Both, as has been noted, are middle distillates and, to some extent, in competition with one another. Home heating oil and transportation diesel are chemically identical, but in the refinery they are processed in slightly different ways for their respective purposes. In addition to having specified regulations and taxes, transportation diesel has a low sulfur standard, meaning that it must contain 0.05% sulfur or less. Home heating oil is required by law to contain not more than 0.5% sulfur content, but due to unintentional mixing of transportation diesel and home heating oil at the refinery, the sulfur content of home heating oil usually hovers around 0.2%.

Table 2 shows recent demand for products that fall within the parameters of distillate fuels. In 2006, diesel fuel represented nearly 63% of distillate sales while residential home heating oil was 8% of sales. This is compared with 58% and 10.8%, respectively, in the year 2002.

Table 2. Sales of Distillate Fuel Oil by End Use in the United States: 2002-2006

(thousand gallons)

Energy Use	Distillate Fuel Oil				
	2002	2003	2004	2005	2006
U.S. Total	59,342,633	63,854,776	62,257,934	63,164,569	62,192,027
Residential	6,376,653	6,927,070	6,644,939	6,154,461	4,984,826
Commercial	3,293,387	3,686,537	3,383,061	3,224,216	2,808,786
Industrial	2,384,383	2,394,445	2,326,604	2,459,711	2,463,676
Oil Company	770,682	513,511	472,920	472,922	636,788
Farm	3,418,452	3,200,809	3,189,014	3,215,819	3,261,345
Electric Power	750,557	1,147,727	823,380	906,976	656,355
Railroad	3,245,482	3,656,657	3,047,491	3,447,630	3,552,430
Vessel Bunkering	2,078,921	2,216,921	2,139,643	2,005,564	1,903,138
On-Highway Diesel	34,308,885	37,103,563	37,125,239	38,053,129	39,118,301
Military	357,359	415,702	358,682	268,553	327,827
Off-Highway	2,357,872	2,591,833	2,746,960	2,955,589	2,478,554

Source: Department of Energy, Energy Information Administration.

Table 2 also suggests that the distillate fuel market in the United States is not a growth market. The total demand for distillates was no higher in 2006 than in 2003, and less than 2% higher than the weak demand year of 2002. On-highway diesel was the only sector that showed continuous growth over the period. Other sectors, like residential and commercial, suggest seasonality related to the weather. Some sectors, like vessel bunkering, electric power, and military showed declining demand.

Differing sectoral demand patterns within the same product group makes it likely that, in pricing terms, those sectors with the relatively strongest demand patterns might be charged prices which help to offset the lower returns that might be earned in sectors with weaker demand. For example, since all of the distillates are joint products of the refining process, all must find a market. However, if one segment of the market, say use in electric power generation, is relatively weak and declining, and another, on-highway use is increasing, it is likely that electric power distillates may be sold at a discount, while on-highway distillates may be sold at a premium.[5]

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[5] Economists identify joint products in production as products which must be produced together. The nature of the technology, or the raw materials, are such that if one product is produced, each of the products in the joint product group must be produced, even though the

(continued...)

Diesel and Gasoline Prices

The retail prices of gasoline and diesel fuel have four major components: the price of the crude feedstock; federal and state taxes; the cost of refining, reflected in what is referenced as the "refiner margin"; and the costs of distribution (transportation) and marketing. As the price of crude rises or fluctuates, along with any demand pressures, the relative percentage share of these components of retail price will shift. The observed drop in the share represented by state and federal taxes — values that are constants over the period shown below — is a reflection of the significant change in the retail sales price for gasoline and diesel fuel. These percentages for the last year for both gasoline and diesel fuel are set out in **Tables 3** and **4**, and depicted as graphs in **Figures 1** and **2**.

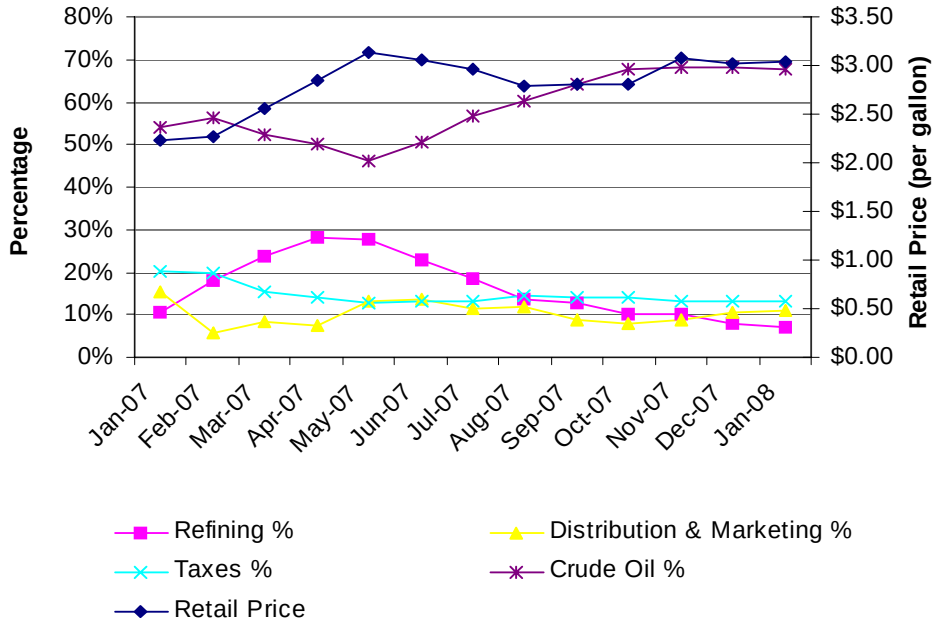
Table 3. Components of Retail Gasoline Price: January 2007-January 2008

Mo/Year	Retail Price (Cents per gallon)	Refining (percentage)	Distribution and Marketing (percentage)	Taxes (percentage)	Crude Oil (percentage)
Jan-07	224.0	10.6	15.2	20.3	53.9
Feb-07	227.8	18.0	5.8	20.0	56.3
Mar-07	256.3	23.6	8.5	15.5	52.3
Apr-07	284.5	28.1	7.6	14.0	50.3
May-07	314.6	27.9	13.3	12.7	46.1
June-07	305.6	22.7	13.7	13.0	50.5
Jul-07	296.5	18.4	11.4	13.4	56.8
Aug-07	278.6	13.5	11.8	14.3	60.4
Sep-07	280.3	12.8	8.6	14.2	64.3
Oct-07	280.3	10.1	8.1	14.2	67.6
Nov-07	308.0	10.0	8.7	13.0	68.3
Dec-07	301.8	8.1	10.5	13.2	68.1
Jan-08	304.3	7.8	11.1	13.1	67.9

Source: Energy Information Administration, Department of Energy. [http://tonto.eia.doe.gov/oog/info/gdu/gaspump.html]

[5] (...continued)
demand conditions for each product may be very different.

Figure 1. Components of Retail Gasoline Price: January 2007-January 2008



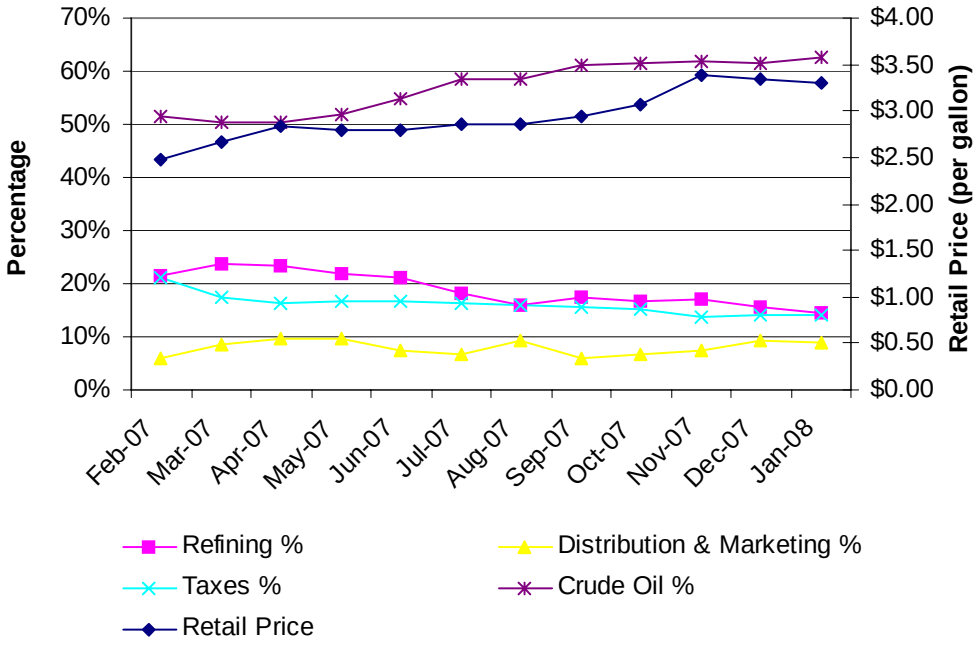
Source: Energy Information Administration, Department of Energy. [http://tonto.eia.doe.gov/oog/info/gdu/gaspump.html] Adapted by CRS.

Table 4. Components of Retail Diesel Price: January 2007-January 2008

Mo/Year	Retail Price (Cents per gallon)	Refining (percentage)	Distribution and Marketing (percentage)	Taxes (percentage)	Crude Oil (percentage)
Feb-07	248.8	21.5	5.8	21.1	51.5
Mar-07	266.7	23.6	8.7	17.4	50.3
Apr-07	283.4	23.4	9.7	16.4	50.5
May-07	279.6	22.0	9.6	16.6	51.9
June-07	280.8	21.0	7.5	16.5	54.9
Jul-07	286.8	18.3	6.8	16.2	58.7
Aug-07	286.9	16.0	9.2	16.1	58.7
Sep-07	295.3	17.4	5.9	15.7	61.0
Oct-07	307.5	16.7	6.6	15.1	61.6
Nov-07	339.6	17.1	7.3	13.7	61.9
Dec-07	334.1	15.4	9.1	13.9	61.6
Jan-08	330.8	14.6	8.9	14.0	62.5

Source: Energy Information Administration, Department of Energy. [http://tonto.eia.doe.gov/oog/info/gdu/dieselpump.html]

Figure 2. Components of Retail Diesel Price: January 2007-January 2008



Source: Energy Information Administration, Department of Energy. [http://tonto.eia.doe.gov/oog/info/gdu/dieselpump.html] Adapted by CRS.

Tables 3 and **4** suggest that the reason for the shift in the relative prices of gasoline and diesel fuel cannot be easily be identified through cost growth at any particular stage of the production process. However, part of the explanation may be in the behavior of refining as a percentage of price. The decline in refining cost in gasoline has been greater than the decline in refining cost in diesel. This pattern suggests that the ability of refiners to pass through cost increases to the consumer is stronger in diesel than in gasoline, and that there are significant recoverable costs that have been added in diesel refining. Both may play a role. As is discussed later in this report, mandated refinery investments have been required in diesel fuel refining to meet new product specifications.

On the demand side, the second half of 2007 and early 2008 have been characterized by record-setting crude oil prices. Gasoline prices lagged the increase in crude oil prices, leading to shrinking refiner margins and profitability. Possibly, because diesel fuel is an intermediary product in commercial use, and as such can be expected to be passed through to final consumers, refining costs as a percentage of cost remained stronger.

It is expressly because refiners often absorb the initial increases in crude prices that some are predicting that, if crude prices remain roughly in their current range or go higher, further price increases in all highway fuels are likely. How steep these increases may prove to be will depend very critically on the demand response to the

price of motor fuels. Gasoline demand is recently observed to be relatively flat, and stocks of gasoline are unseasonably high. However, with the start of the summer driving season still some weeks off, any prediction about the price, supply, and demand for gasoline (and diesel fuel) during the summer of 2008 would be conjecture at best.

Factors Influencing Gasoline-Diesel Fuel Price Differential

A variety of factors, some cyclical, and some structural, have likely contributed to the break-down of the traditional pattern of relative prices between gasoline and diesel fuel. These are identified and described in turn.

World Market Balance

Growing petroleum product demand, including demand for diesel fuel, in China, Europe, and the United States has put pressure on the ability of refineries to meet production requirements. Demand growth in China is primarily tied to the level of economic growth, expanding both industrial and consumer demand. While the overall growth in petroleum demand in Europe has not been high, demand for diesel fuel over gasoline has increased. The European automobile and light truck fleet has moved in the direction of diesel fuel. In the United States, the demand for gasoline has continued to increase. Even though crude oil prices have risen since 2004, demand for gasoline in the United States over the same period continued to increase.

In a world market where the major producers sell their products in virtually every geographic and product segment, price effects will have a tendency to move from one part of the market to another. If strong demand for diesel fuel exists in Europe and places upward pressure on prices, the effect is also likely to be felt in the U.S. market. Even if it were possible to wall off the U.S. market from higher prices, it is unlikely that it would be helpful. If a price spread between gasoline and diesel, greater than the cost of shipping, develops between Europe and the United States, a major oil company might be inclined to draw diesel fuel from the U.S. market and sell it in Europe to earn a greater profit. The potential for transactions of this type transmit price increases from one geographic market to others, even if the trade flow does not occur.[6]

U.S. imports of diesel fuel have been in the 200 to 400 thousand barrels per day range since 2004. If the import price of diesel fuel exceeds the domestic price of the same fuel, and given that in the market all product is sold at the same price, all prices will rise to the level of the higher cost imported fuel. In terms of the example cited above, tight demand and supply conditions in the European diesel fuel market are transmitted to the U.S. markets as prices tend to equalize.

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[6] Economists relate this kind of analysis to opportunity costs. Opportunity costs are the value of a good or service in its next best alternative use. Prices are generally at, or above, their opportunity values, but it is unlikely they will trade below that value.

Refinery Output

U.S. refinery utilization rates in recent years have been high, generally at or near 90%, reflecting strong domestic demand for most petroleum products. The product mix has generally been optimized to produce a maximum amount of gasoline. This could be true even in times when the price of diesel fuel is above the price of gasoline. Record profit levels in the oil industry have increased public scrutiny of oil company operations. Although prices of all petroleum products have been high, and market conditions tight, physical shortages of transportation fuels have not been generally observed. If the general motoring public had to confront high gasoline prices at the same time that physical shortages were developing, the pressure to tax or regulate oil company profits and product prices might grow. As a result, it may be that a major priority of the oil companies supplying the U.S. market is to avoid shortages. To avoid shortages, the U.S. imports gasoline and gasoline blending components. These imports now generally exceed 1 million barrels per day, augmenting domestic gasoline production, and avoiding the likelihood of physical shortages of gasoline.

A possible result of maximizing gasoline output at the refinery may be to make the supply of diesel fuel relatively less available when compared to any particular level of demand, resulting in stronger upward pressures on diesel fuel prices compared to gasoline prices. In this way, even though all petroleum product prices are rising due to the increasing price of crude oil, the relative prices of diesel fuel and gasoline could shift because of an emphasis on gasoline production.

Sulfur Content

The Environmental Protection Agency (EPA) in 2001 promulgated new rules concerning the sulfur content of diesel fuel that began to go into effect in 2006. Ultra low sulfur diesel (ULSD) contains 15 parts per million of sulfur, compared to 500 parts per million or more in uncontrolled diesel fuel. Refineries were to begin producing 80% of their output of diesel fuel as ULSD in June 2006, with availability at fuel outlets for on-highway use by October 2006. Because the sulfur content is measured at the pump according to EPA regulation, special transportation and distribution systems were also needed to avoid fuel contamination. Use of reduced sulfur diesel for off-highway purposes began in 2007, with full implementation of ULSD by 2010.

The American Petroleum Institute estimated that over $8 billion have been spent by refiners to acquire and implement refinery processes for sulfur removal. In addition, hundreds of millions of dollars have been spent to upgrade transportation and distribution systems. These investment costs to meet federal regulation are likely to be passed on to consumers in the form of higher diesel fuel prices.[7] These investment costs increase the refinery cost component of diesel fuel, and if the refiners allocate costs specifically to the cost-generating product, diesel prices should rise relative to gasoline prices.

[7] American Petroleum Institute, *Diesel Fuels*, at [http://www.api.org].

Heating Oil/Seasonality

Home heating oil and diesel fuel are essentially the same product from the refining point of view, and as such, their prices are related in the market. As a result, peaking demand for home heating oil in cold months can have an effect on the price of diesel fuel.

For parts of the United States, the winter of 2007-2008 was colder than usual.[8] Heating oil prices reached a record price of $3.55 per gallon for the week ending March 3, 2008. This record price represented an increase of almost 9 cents from the previous week. These prices represented higher than a year-ago prices for the 22nd consecutive week this heating season. Heating oil demand and high prices have likely contributed to the increases observed in diesel fuel prices.

In addition, the linkages between the domestic diesel fuel market and international markets suggest that cold weather which increases heating oil demand anywhere in the world is likely to contribute to higher heating oil and diesel fuel prices in the United States.

Pricing Practices

In a market economy, sellers of a commodity may set prices at whatever level they think the market will bear. Consumers respond by adjusting their level of purchases. If the consumer's demand is inelastic, or insensitive to price, then sellers have an incentive to charge higher prices. Transportation demand, and hence the demand for fuels including gasoline and diesel fuel, is thought to be relatively price insensitive in the short term. In addition, since diesel fuel is used for mostly business purposes in the United States, it may be treated as an intermediate good; one that is a cost component of a production process leading to some final consumer good or service. As such, any increases in diesel fuel costs are likely to be passed on to the ultimate consumers. If costs can be passed on through a pricing process, there is little need for those who use the product to make adjustments as a result of higher costs.

Although gasoline and diesel fuels are joint products of the refining process, refining companies have the right to apportion the costs of production to segments of the product mix in whatever blend they choose. Refiners may choose to change relative prices within the product mix to take advantage of demand conditions, to alter the composition of demand to match available supply, or simply as a strategy to increase shareholder value.

Conclusion

On the basis of the market dynamics described in this report, the future price path of highway fuels and the relative disparity between the price of gasoline and

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[8] See map of accumulated heating degree days for the United States, November 2007 through March 11, 2008 at [http://www.cpc.ncep.noaa.gov/products/predictions/experimental/ddtest/sdhdd.glf].

diesel fuel cannot be predicted with any confidence. At this time, the price support for diesel fuel is primarily demand-driven, with the United States competing for world supply to supplement domestic production of middle distillates with product imports.

It could be anticipated that, at some point, the price of a fuel could reach a level where there is some demand response. It is unclear what these price points may be. However, owing to the primary use of diesel fuel in the commercial sector for the delivery of goods and some services, demand for diesel is likely to be less elastic because, as has been noted, those costs will be passed on to consumers. Demand outside the United States may also prove to be less elastic. A supply response could ameliorate prices somewhat, but any supply response is bounded by the nature of crude oil and refinery investment.