A Tightening Market for Supply of Heavy Crudes to the US Market

Implications for Refining

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A TIGHTENING MARKET FOR SUPPLY OF HEAVY CRUDES TO THE US MARKET: IMPLICATIONS FOR REFINING

KEY IMPLICATIONS

Recently the incentive for US oil refiners to invest in conversion units has been derailed by the collapse in the differential between light and heavy crude prices. A critical factor driving the light-heavy crude price differential is the availability of heavy and medium crudes relative to the refining system's capacity to process them. IHS CERA analysis indicates that competition among US refiners for heavy and medium crudes has grown for several years. This trend was hidden as the light-heavy differential was widening for other reasons.

- **IHS CERA refinery modeling shows that coking refineries are increasingly bidding up the price of heavy and medium crudes.** US coking capacity has outstripped available coking feedstock, creating increased competition for heavy and medium crudes and a narrower discount of heavy to light crude than would otherwise be the case.

- **US coking refineries will compete for limited feedstock for several years.** IHS CERA expects that the relative tightness for heavy and medium crudes could last until at least 2015. Declining Mexican crude production, stagnant Venezuelan production, and delays in Canadian oil sands projects are bumping up against an expansion of coking capacity in North America.

- **The implications of a tighter market for medium and heavy crudes will vary based on refinery competitiveness.** The largest, most efficient complex refiners may consider securing heavy crude on a long-term basis (one to five years) to keep their competitive advantage by ensuring their plants are filled with the right crude. Less efficient complex refiners will be best served by processing a lighter crude mix or filling conversion units with straight-run residual fuel oil. New upgrading investments are of little interest at this juncture.

—February 2010

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A TIGHTENING MARKET FOR SUPPLY OF HEAVY CRUDES TO THE US MARKET: IMPLICATIONS FOR REFINING

by Olivier Abadie, Aaron Brady, and Jackie Forrest

INTRODUCTION

Oil refiners profit when the value of refined products is higher than the acquisition price of crude oil—the raw material for the products—and the cost of operating the refinery and processing the crude. A long menu of crude oils is available on the world market. Some are heavy and high in sulfur, some light and low in sulfur, and many are in between. Heavier crudes are generally priced at a discount to lighter crudes, because they are more costly to convert to light refined products and because they naturally yield a higher proportion of low-value heavy fuel oil. In recent years refiners able to upgrade heavier crudes have generally been able to realize wider margins than their peers processing light crudes.

However, this price differential between light and heavy crudes—known as the light-heavy spread—has varied dramatically over the years. In the United States, for example, the difference between West Texas Intermediate (WTI), a light, sweet crude (39.6 degrees American Petroleum Institute [API] gravity), and Mexican Maya, a very heavy grade (21.5 degrees API gravity), averaged about $7 per barrel between 2000 and 2003. Starting in 2004 the differential began widening dramatically, rising as high as $22 per barrel in May 2008.

Since that high-water mark, this differential has collapsed—the WTI-Maya spread averaged only about $5 in 2009 (see Figure 1). Similarly in Europe the differential between Dated Brent (a light, sweet grade) and Urals (a medium, sour grade) rose from an average of $1.60 per barrel during 2000–03, widened to average nearly $4 during the first half of 2008, and now sits below $0.50.

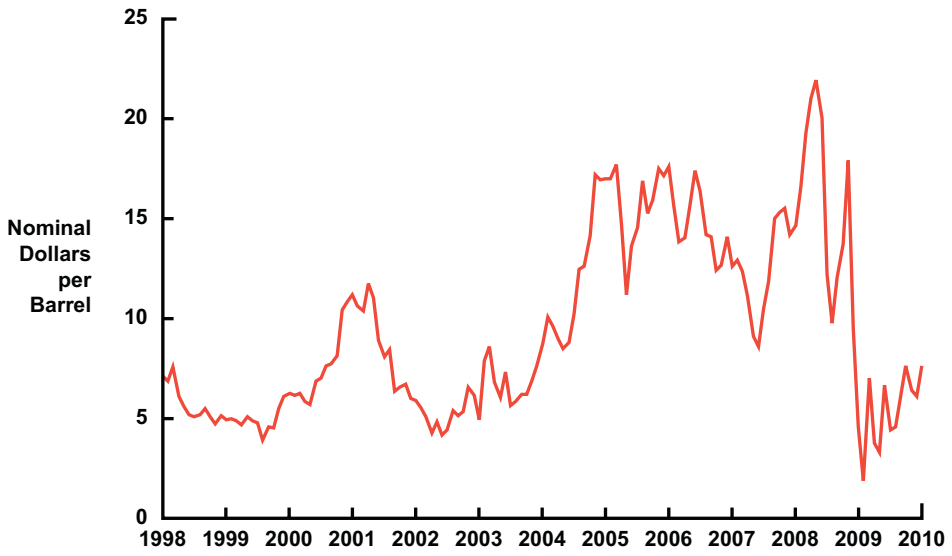
The narrowing of these differentials has hurt complex refiners' profitability and triggered a reevaluation of future refining investments. This trend has also occurred at a time of unprecedented economic vulnerability for the refining industry, especially in OECD countries, where the industry has suffered the largest decline in oil demand since the early 1980s. Utilization rates are unsustainably low, overall margins have fallen, and capacity closures have begun.* Also, total OECD oil demand is likely to have peaked in 2005; we do not expect OECD demand to exceed that level again.**

The light-heavy differential is of critical importance to the attractiveness of refining investments. The refinery kit needed to process heavy crudes is very capital intensive: a typical size coking unit or hydrocracking unit and all associated supporting units requires an investment of $1 billion to over $1.5 billion. If a refiner that has made such costly investments can purchase heavy crude at a steep enough discount over time, such an investment will more than pay for itself. If the savings in crude costs prove to be insufficient to offset the higher

*See the IHS CERA Market Briefing *World Refined Products Outlook: Refining Industry Consolidation Begins.*
**See the IHS CERA Private Report *Peak Oil Demand in the Developed World—It's Here.*

Figure 1

WTI less Maya Crude Oil



Source: IHS CERA; Platts.
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operating and capital cost, then the refiner would have been better off buying lighter crude and forgoing the investment.

Globally the refining industry has invested aggressively in upgrading capacity in order to adapt to growth in light refined product demand and to increase profitability by leveraging the discounted price of the heavy crudes. Worldwide the volume of refinery crude processing capacity with associated coking units has grown by 7 million barrels per day (mbd) since 2000 to 30 mbd, and construction has begun or will soon be under way for an additional 2.5 mbd of capacity backed by coking. These new, more complex refineries will require growing volumes of medium and heavy crudes to fill their conversion units. Could this large increase in deep conversion refinery capacity intensify the competition for such grades and, at least in part, cause a narrowing of the light-heavy crude price differential?

In this Private Report IHS CERA investigates the supply and demand dynamics for heavy and medium crude in the US refining market and their influence on the light-heavy crude price differential as represented by the spread between Maya and WTI. The US oil market is a key region for observing the interplay between refining demand and crude supply since it is home to much of the world's coking capacity and has relatively abundant data on crude supply and refining capacity.

The balance of crude supply and demand in the US market is explored in this report through

- an evaluation of which refinery type has set the price of heavy crude over time

- a quantification of the growth of new coking capacity
- an analysis of the evolution of heavy and medium crude supply

Our analysis suggests that coking refineries in the United States have competed increasingly for heavy and medium crudes over the past several years. Recently, of course, this growing tightness has been reinforced by OPEC's decision to reduce crude production—especially of the heavy and medium grades—in response to the recession-triggered pullback of world oil demand in 2008–09. However, long term, our analysis also suggests that supply of heavy and medium crudes will remain tight relative to coking and cracking refining capacity until around 2015.

REFINERY COMPETITION FOR HEAVY CRUDE

Many factors drive the price of heavy crude relative to light crude (see the box "Factors Influencing the Heavy-Light Crude Price Differential"). Of key importance, however, is the relative supply and demand for heavy grades:

- **The supply of heavy crude fluctuates over time, based on several factors.** These include the decline rates of existing heavy crude fields, the productivity of new heavy crude fields coming into production, and decisions by OPEC producers.
- **Increases in deep conversion refining capacity result in a corresponding potential increase in heavy crude demand.** The underlying demand for refined products is also important; during periods of especially strong demand for light products, refiners with limited upgrading capacity tend to increase their demand for light crudes because of the oils' inherently higher yields of diesel and gasoline compared to heavier grades.

When purchasing crude oil, refiners bid on different grades based on their potential margin, i.e. the value of the petroleum products the refiners can produce minus the costs for the crude, transport, and refining (see Figure 2).

- **Coking refineries will pay the highest price for heavy crude.** These refineries—the most complex in the marketplace—are equipped with a catalytic cracker or hydrocracker plus a coker which upgrade residue into light products. Relative to other refineries, coking refiners are willing to pay the most for heavy crude because they can upgrade most of it into valuable light products and get the highest possible margin.
- **Cracking refineries are next in line.** If the total supply of heavy crude exceeds available coking refining capacity, its price is then set by the next buyer in line who can absorb the incremental heavy barrel—the cracking refiner (e.g., a refinery armed only with a catalytic cracking or hydrocracking unit). It can upgrade a lower volume of residue into light products compared to its peers with coking units and therefore will be incentivized to process heavy crude only if it can pay a lower price than the coking refinery.
- **Occasionally, simple refineries are the marginal buyers, at a steeper discount.** If there is still heavy crude available once coking and cracking refineries have filled their

Factors Influencing the Light-Heavy Crude Price Differential

Many factors influence the price difference between heavy and light crudes. The relative balance between refining capacity and crude supply is just one of numerous influences on this differential.

- **In 2004 growing demand made margins soar for light products—especially middle distillates—**providing significant incentive to operate all refining capacity, including available simple capacity. Simple refineries increased their throughputs but in the process produced incremental volumes of residual fuel oil, which kept the heavy fuel market well supplied. As crude and light product prices soared, residual fuel prices lagged. Correspondingly, heavy crude prices also lagged light crude prices, since heavy crudes yield disproportionately more lower-value residual fuel.
- **In 2008, as oil demand collapsed, Gulf OPEC producers cut production sharply** in an attempt to balance the world oil market. The production cuts were disproportionately targeted toward medium and heavy sour grades. Refineries also processed less crude in reaction to decreasing demand, and refinery production of residual fuel oil also fell correspondingly. The tighter fuel oil balance strengthened its price and thus lent additional support to heavy crude prices. This contributed to a tightening of the light-heavy differential.

Looking forward, many of these factors will undoubtedly shift again. Some widening of the light-heavy spread from today's narrow levels could occur if the resumption in world oil demand is especially strong, causing OPEC to return the barrels of heavy crude it removed from the market in response to the demand pullback of 2008–09.

Furthermore the world refining sector is currently facing large volumes of overcapacity, and inefficient refineries are likely to shut down. At the same time large volumes of new complex refining capacity are coming online around the world, especially in developing countries. The new complex refineries will convert residual fuel to lighter products, while the loss of the mothballing of simple and cracking refineries will mean that less residual fuel oil is produced. This would reinforce the trend toward narrow light-heavy crude oil price differentials.

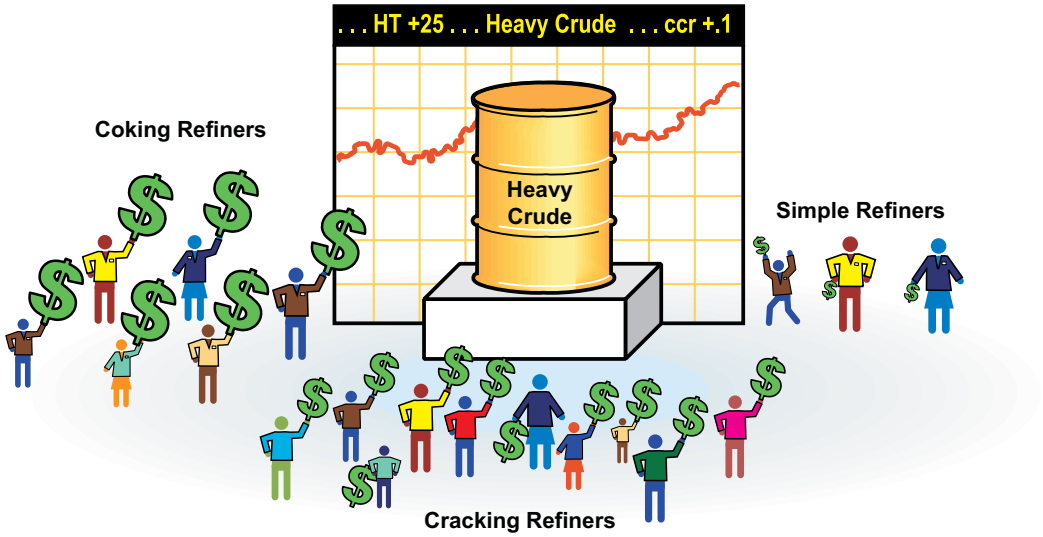
One demand-side factor could cause a widening during the next decade. New ship emissions regulations could force ship operators to use diesel as bunker fuel instead of fuel oil. This could cause total world fuel oil demand to drop much faster than the slow decline of the recent past, causing the differential to widen.

Opposing this potential demand change will be a shift on the supply side. A shift in the composition of global feedstocks toward lighter liquids would tend to cause a tightening of the light-heavy spread. Over the longer term, global liquids supply growth will tend to be dominated by natural gas liquids, condensates, and biofuels. As these light liquids gain a larger share of world liquids production, world refinery feedstocks will get lighter over time, especially as increasing volumes of condensate are spiked into conventional crude oil. Feedstock for conversion units may fall short, given that these noncrude light liquids yield no fuel oil. This will curtail the total volume of fuel oil available, supporting higher fuel oil prices and, in turn, narrower heavy-light differentials.

The return of oil demand growth at a global level is the key for a return to wider light-heavy crude price differentials. In our view average differentials will be modestly wider in the next few years with the WTI-Maya spread at $7.40 and $8.25 per barrel in 2010 and 2011, respectively (or 87 percent and 89 percent of WTI crude price), and a return to the days of extremely steep discounts for heavy oil in the medium term is unlikely.

Figure 2

Bidding for Heavy Crude Based on Refinery Type



Source: IHS CERA.
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conversion units, simple refineries then become the price setter for heavy crude. They do so by bidding at an even lower price than cracking refineries. Simple refiners will bid the lowest price because the revenue from the resulting refined product mix—a substantial portion of which will be low value residual fuel oil—is less than for any other type of refinery.

In summary, when less complex refineries are needed to clear an overhang of heavy crude supply, the value of heavy crude drops, and the light-heavy price differential widens. Conversely if there is more coking refinery capacity than heavy crude available, the light-heavy differential narrows, since heavy crude barrels will not need to be discounted to motivate less complex refineries to buy.

The marginal buyer of heavy crude is one of a number of factors that influence its price. The relative prices of light and heavy refined products also play a major role in determining the light-heavy differential for crude. When light product prices such as diesel or gasoline are strong and residual fuel oil prices are relatively weak, heavy crude will sell at a relatively wide discount to light, sweet crude, since heavy crude yields a large volume of heavy fuel oil. This was a major factor during 2004–08, in which strong world demand growth for light products caused light-heavy crude differentials to widen dramatically because of the expanding price difference between gasoline or diesel and residual fuel oil.

Absolute crude prices also matter. For example, residual fuel oil was discounted to WTI by as much as $30 per barrel during the spring of 2008 when light, sweet crude was trading at over $100 per barrel. Clearly, however, such a discount is not mathematically possible if

crude is only at $25 per barrel. Moreover, residual fuel oil competes in the nontransportation sectors with other boiler fuels such as natural gas or coal. Therefore in an environment of rapidly escalating light crude prices, the price of residual fuel oil may not be able to keep pace because of competition from these other lower-priced fuels. Unsurprisingly, then, higher crude oil prices have tended to be associated with wider light-heavy differentials, as measured by the absolute dollar-per-barrel difference in prices (see Figure 3).

ACTUAL HEAVY-LIGHT PRICE DIFFERENTIALS ILLUSTRATE A GROWING SHORTAGE OF HEAVY AND MEDIUM CRUDES

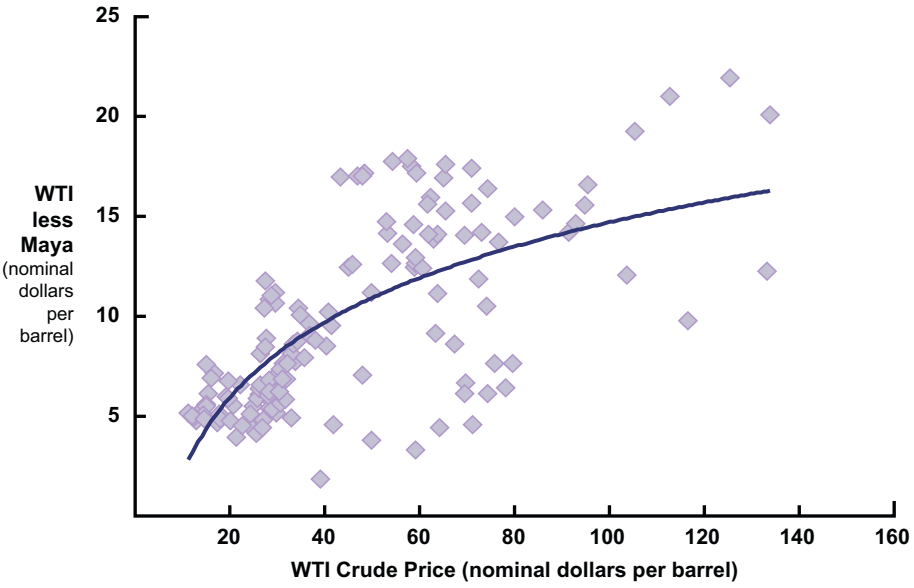
Although light-heavy spreads from 2004–08 were growing increasingly wide on a dollar-per-barrel basis, a subtle change was occurring in the availability of heavy crudes relative to their demand in the US market. Increasingly growth in the capacity for processing heavy and medium crudes was outpacing growth in the availability of these grades.

Modeling the Light-Heavy Crude Price Differential

These contrasting trends can be illustrated by comparing the prices that a range of refinery types were willing to pay for light and heavy crude. IHS CERA employed our material balance refinery model to mimic the netbacks for WTI and Maya when processed by three different types of US refineries—coking, cracking, and simple refineries (see the box "Refinery Economic Modeling"). In a perfect market, the actual price differential between WTI and Maya should be equivalent to the difference between the WTI netback and the

Figure 3

WTI less Maya Differential versus WTI Price



Source: IHS CERA; Platts.
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Refinery Economic Modeling

A refining model is essential to understanding the economics of how various refineries decide which crudes to buy. Key variables to consider for study are the type of refinery, the crudes processed, and the time period.

- **Refinery type.** IHS CERA ran the model for three distinct types of refineries:
  - **Simple refinery.** This generally refers to a hydroskimming or topping refinery whose main unit is the crude distillation unit, which boils crude oil at atmospheric pressure to separate gasoline, naphtha, jet fuel, gasoil, and heavy residue. A simple refinery has limited flexibility to alter the volume or quality of each refined product, which are determined entirely by the natural properties of the crude oil that is being processed.
  - **Cracking (complex) refinery.** This refinery has more sophisticated upgrading units that allow it to modify the proportion of refined product types it produces by converting or upgrading some of the heavy fuel oil molecules into more valuable light components. Residual fuel oil is sent to a vacuum distillation unit, where it is separated into vacuum residue and vacuum gasoil. The vacuum gasoil is then sent as a feedstock to either a fluid catalytic cracker unit or a hydrocracking unit, where it is cracked into lighter, more valuable products such as gasoline and diesel. The vacuum residue is marketed as heavy fuel oil.
  - **Coking (very complex) refinery.** This refinery is similar to a complex refinery, except that it has a coking unit that upgrades most of the vacuum residue into light products and coke. Thus, of all refinery types, coking refineries convert the highest volume of residual fuel to more valuable products. This type also has the greatest "appetite" for heavy crudes since it can accommodate a heavier crude feedstock while still achieving a high yield of light products.
  - Coking refineries are much more common in the United States than in the rest of the world. Not only are there more crackers in the United States, there are also more cokers and residue hydrocrackers. Half the refineries in the United States have cokers, compared with only one in six in Europe.
- **Crude.** The key crude grades studied in the model included the key light benchmark US crude oil—WTI (39.6 degrees API, 0.24% sulfur), and the main US Gulf Coast heavy crude benchmark, Mexican Maya (21.5 degrees API, 3.4% sulfur).

The refinery model simulated the gross margin for the three types of refineries, using both WTI and Maya as feedstock. Margins were calculated using refined product prices observed over the period 2000–09.*

*Gross margin is defined as the total revenues received from the refined products manufactured and sold by the refinery less the total cost of the delivered crude oil processed by the refinery. Other operating costs are not included.

Maya netback of the marginal refinery, which sets the price. As explained above, if there is more coking capacity than coking feedstock (generated by the heavy and medium crude available), the actual market price differential between WTI and Maya should be close to

the calculated theoretical netback differential between WTI and Maya for a coking refinery.* Conversely, if there is excess heavy crude in the market, the actual WTI-Maya differential in the market will be closer to the calculated theoretical netback differential between WTI and Maya for a cracking refinery or even a simple refinery.

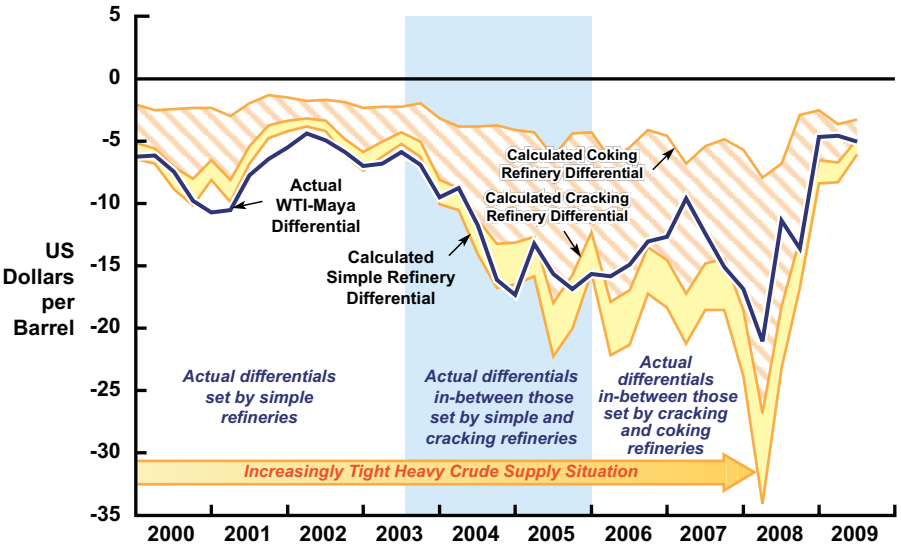
The calculated theoretical netback differentials of WTI and Maya crude for simple, cracking, and coking refineries in the United States—as generated by the IHS CERA refinery model—are plotted against the observed market WTI-Maya differential in Figure 4. The range of price differentials are framed by the model's calculated netback differentials for simple and coking refineries, but there are periods where the actual differential closely follows the calculated theoretical netback differential for one type of refinery, and other periods where it moves closer to that of another type, suggesting that the supply-demand balance for heavy crude has shifted over time:

- **Heavy crude surplus.** During 2000–04 the model shows that the actual WTI-Maya differential was closest to the calculated theoretical netback differential for a simple refinery, suggesting that there was more heavy crude available in the US market than was able to be processed by cracking and coking refineries.

Figure 4

Refinery Model Results

(netback differentials for WTI and Maya based on three refinery types)



Source: IHS CERA; Platts.
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*Medium crudes were included in the analysis because coking refineries usually don't process heavy crudes exclusively, but rather run a mixture of both heavy and medium crudes. For this analysis, heavy crudes are defined as those grades with an API of less than 27 degrees and medium grades as having an API between 27 and 34 degrees. Most heavy grades supplied to the US are imported from Mexico, Canada, and Venezuela or produced in California, while US domestic medium crudes comprise grades such as West Texas Sour, Mars, and Southern Green Canyon.

- **Heavy crude relatively balanced.** During 2004–05 the actual differential fell closest to the calculated theoretical netback differential for a cracking refinery, indicating a more balanced situation.

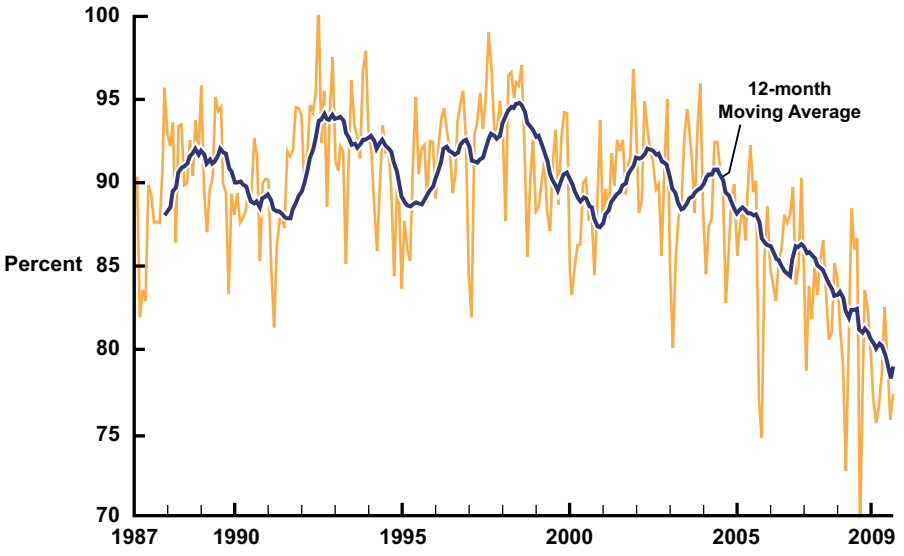
- **Heavy crude tightens.** From 2006 onward the actual differential moved above the calculated theoretical netback differential for a cracking refinery, suggesting that since 2006 there has not been enough heavy crude to fill up coking refineries. This is further reinforced by data showing that coking utilization has been falling since that time—evidence that coking refineries have increasingly not been able to fill their units profitably (see Figure 5).

As mentioned above this competitive dynamic for heavy crude is not the only factor influencing the light-heavy spread. However, it still has a substantial influence on its ultimate level. According to IHS CERA modeling results, the delta between the calculated theoretical netback differential for WTI and Maya of a simple refinery and that of a cracking refinery ranged from $1.30 to $3.70 per barrel, or 20 to 35 percent of the actual Maya-WTI differential itself, from 2000 to 2009. In other words, if competition among coking refineries had not been increasing during this time, the actual light-heavy differential would have been as much as $3.70 per barrel wider.

The model's results, suggesting a shift from surplus to shortage of heavy crude in the United States, are also in line with the trend of Maya's relative value to WTI. Although Maya did not keep up with the escalation of WTI on an absolute dollar-per-barrel basis from 2004 to 2008, Maya did strengthen in relative terms. Maya bottomed out at about 65 percent of

Figure 5

Coking Unit Utilization in the United States



Source: IHS CERA; US Energy Information Administration.
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WTI's value at the end of 2004 but steadily strengthened thereafter, averaging about 83 percent of WTI in 2008 and more than 90 percent in 2009 (see Figure 6). Many industry participants view the ratio between light and heavy crudes as the key indicator of market conditions rather than the absolute dollar-per-barrel differential.

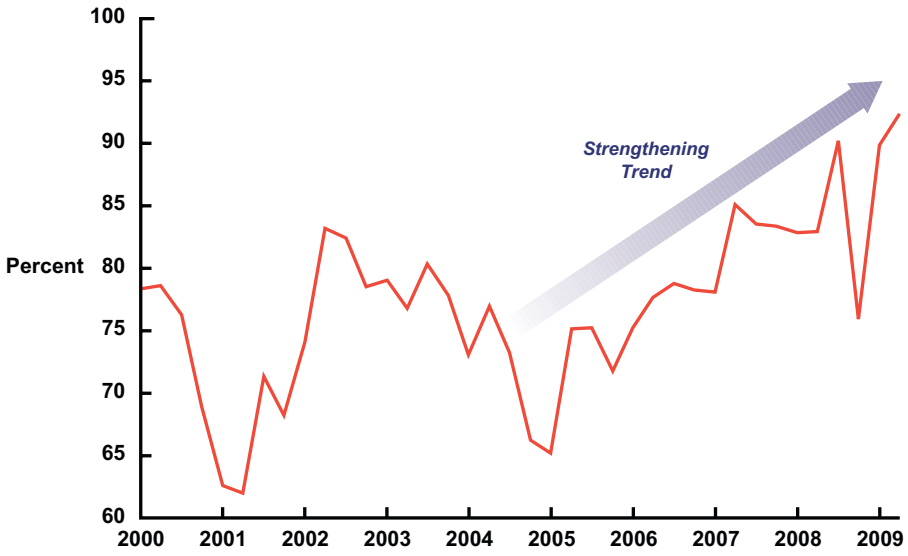
COKER FEEDSTOCK ANALYSIS CONFIRMS AND SHOWS DECLINE IN MEDIUM CRUDE SUPPLY

IHS CERA crude oil supply analysis, showing a decline in the availability of medium and heavy crudes to US refiners, reinforces the modeling results.

Combined medium and heavy crude supply in the United States (both domestic production and imports) has declined by 1.25 mbd (about 10 percent) from 2004 to 2009 (see Figure 7). Medium crudes are entirely responsible for this overall reduction: supply of both domestic and imported medium grades into the United States has declined by 1.4 mbd since 2004, while supply of heavy grades has increased by 0.15 mbd. Medium crudes have been less available owing to lower US domestic production and especially lower imports.* As a result of this decline in medium and heavy crude availability, the coker feedstock (vacuum residue) generated from such crudes has also declined.

Figure 6

Maya/WTI Price Ratio



Source: IHS CERA; Platts.
00104-14

*Imports of medium grades have been notably lower from Canada, Saudi Arabia, Nigeria, Iraq, and Venezuela since 2004. On the other hand, heavy crude supplies have increased by about 0.15 mbd during the same period, with declining availability of domestic and Latin American supply being offset by increases from Canada

Figure 7

Medium and Heavy Crude Supplied to the US Market
(includes both domestic production and imports)

Source: IHS CERA; US Energy Information Administration.
00104-15

Meanwhile during this same period US coking capacity increased by 125,000 barrels per day (bd). The key result has been that, overall, the maximum potential supply of coker feedstock relative to coking capacity has decreased from 107 percent in 2003 to 98 percent in 2009 (see Figure 8).* This confirms that coking refiners are now competing for increasingly tight supplies of crude to fill their conversion units, which tends to narrow light-heavy differentials.

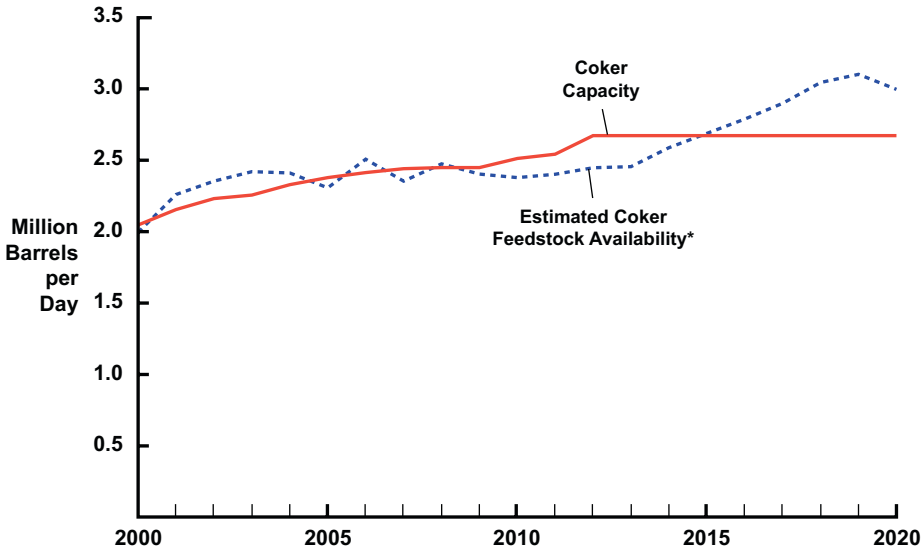
A FORWARD LOOK: HOW WILL THE US HEAVY AND MEDIUM CRUDE BALANCE EVOLVE?

The US supply and demand balance for heavy and medium crudes is just one—albeit a major—part of the equation that determines how the light-heavy price differential will evolve going forward. But the US market is fully integrated into the world crude market and is therefore influenced by global supply and demand factors that affect medium and heavy prices. If a significant surplus of medium and heavy crudes relative to coking capacity emerges globally, the current tightness in the heavy crude market would unwind and would affect the economics of US refiners as well as their counterparts in other markets.

*The maximum volume of vacuum residue yielded by these heavy and medium crudes was estimated assuming a deep cut vacuum column with an initial cut point of the crude at 1,050 degrees Fahrenheit, which provided a proxy for available volumes of coker feedstock.

Figure 8

US Coker Feedstock Availability versus US Coker Capacity



Source: IHS CERA; US Energy Information Administration.
Note: Coker feedstock availability estimated from crude oil yields of residual fuel, assuming 40 percent of US coker units have initial feed cut point of crude at 1,000 degrees Fahrenheit and 60 percent of cokers have initial feed cut point at 1,050 degrees Fahrenheit. Coker feedstock availability is calculated on a net basis after deducting volumes of residual fuel demanded for other uses such as bunker fuel.
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Tight US Heavy and Medium Crudes Balance in the Medium Term

Although the future domestic production path of heavy and medium grades in the United States can be estimated with a reasonable degree of certainty, the potential for import growth from many traditional US suppliers is unsure, which generates great uncertainty about the potential future increase in the total supply of these grades in the United States.

As mentioned above, part of the recent shortfall in medium and heavy crudes has been reinforced by OPEC's preferential cut in those grades in response to the recessionary pullback in world demand. In the short to medium term some of this heavy and medium crude could return to the market as world oil demand resumes growth, but its impact will be limited, for two reasons:

- **Much of this heavy and medium crude is expected to be absorbed** by new complex refineries in the growing developing world.
- **Simpler refineries with little upgrading capacity are likely to shut down in the OECD** owing to overcapacity and weak demand in their markets. This will tend to reduce demand for light crudes.

Over the longer term, however, the following scenario is most likely:*

- **Heavy crude availability to US refiners will not improve for several years but is expected to grow by 2020.** Heavy crudes currently represent one third of the crude refined in the United States. Canada, Venezuela, and Mexico contribute more than 70 percent of these grades; growing imports from these countries are needed to offset declining US production of heavy crude. Recently Mexican heavy crude production has been in decline, and Venezuelan production has been flat to declining, and such trends are projected to continue for at least the next three to four years. IHS CERA estimates that by 2020, with a more favorable political and investment climate for oil production in these two countries, Venezuelan and Mexican heavy crude productive capacity could be slightly higher than today. The outlook for heavy crude production growth in Canada is more robust, based on known oil sands projects. Supply could grow by 60 percent by 2020. However, most of this increase is expected to occur after 2015 owing to numerous project delays.

- **Outlook for medium crudes depends on imports.** Medium grades represent 45 percent of the crude refined in the United States. About 40 percent of this is produced domestically, and we do not expect domestic volumes to grow substantially by 2020. However, more than 35 countries currently supply medium grade crudes to the United States, and IHS CERA sees substantial potential for productive capacity growth by 2020 from a number of these suppliers, particularly Iraq and Brazil. The realization of these production gains, however, is subject to a number of aboveground risks.

- **US coking capacity is expected to continue increasing until about 2013.** Based on known projects already under construction or likely to proceed, we expect US coking capacity to increase by almost 400,000 bd from 2009 to 2013, a volume comparable to the increase from 2000 to 2008 (see Figure 9).** Post-2013 IHS CERA expects the pace of new coking construction to slow.

Thus it appears likely that over the next five years US coking refiners will have to compete for limited availability of feedstock owing to the stagnant outlook for heavy and medium crude supplies and the addition of new coking capacity. Coking refineries are therefore most likely to be the price setters for heavy crude, which implies a narrower light-heavy differential than if medium and heavy crude market conditions were not as tight.***

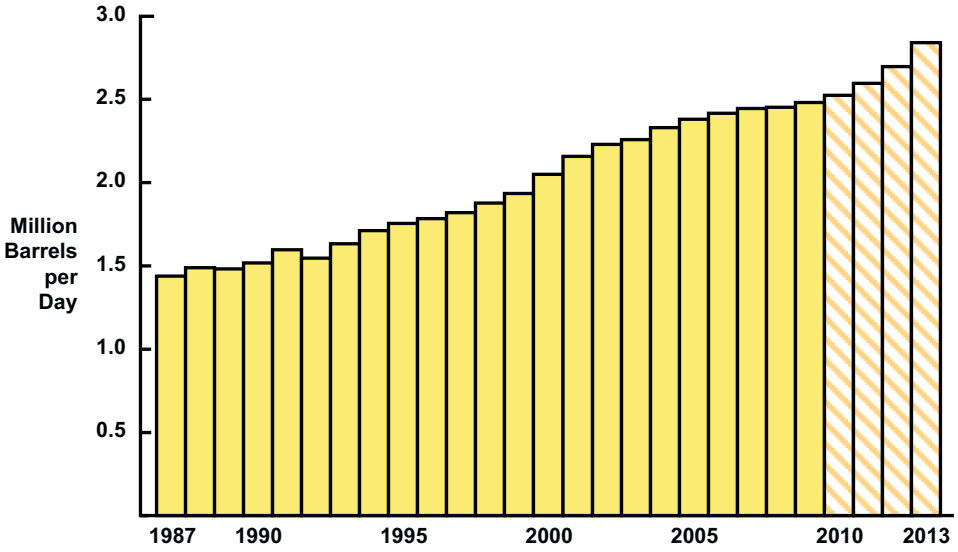
*In projecting future heavy and medium US crude supply over the longer term, IHS CERA assumed that US imports from each country grew (or declined) at a rate similar to our projected overall supply change for each country. Exceptions were countries estimated to have large increases in crude supply (over 1 mbd) over the next ten years, such as Iraq, Brazil, Saudi Arabia, and Canada. For these high-growth countries, US imports were assumed to increase at higher rates than production growth.

**This growth could be somewhat moderated by the shutdown of less-efficient coking capacity in the United States. For instance Valero's 210,000 bd Delaware City refinery, which possesses a 50,000 bd coking unit, was recently shut down permanently.

***Conversely, if heavy and medium crude supply into the United States does not materialize as projected, or if US coking capacity expands more than expected, then the tight supply situation for heavy and medium grades could extend beyond 2015.

Figure 9

US Coking Capacity, 1987–2013
(history and projection)



Source: IHS CERA; US Energy Information Administration.
00104-17

A Glance at the Global Picture

An analysis of the global balance for heavy and medium crudes is a more daunting exercise. Visibility about new refinery projects toward the end of the next decade is extremely limited, and the exact pace of new upstream projects is uncertain, given the uneven pace of world oil demand growth and industry investment. Nevertheless an analysis of existing refinery projects and trends in global crude supply allows us to draw important high-level conclusions about the future.

Globally demand for heavy and medium crudes is increasing, as substantial new volumes of complex refining capacity are brought online in the developing world, especially in India and China. On the supply side, though, world production of heavy and medium crudes will likely continue to increase, but only enough to keep pace with new coking refinery capacity additions. A surplus of heavy and medium crudes, relative to new additions in coking capacity, is not expected to emerge before 2015. As a result, substantial imports into the United States and a loosening of the market for heavy and medium crudes appear unlikely before that time.

This suggests that the light-heavy spread will remain narrow until 2015, although, as discussed above, the supply-demand balance for heavy and medium crudes is not the only determinant of this differential (see the box "Factors Influencing the Light-Heavy Crude Price Differential"). For instance a resumption in the tightness of the diesel market similar to that between 2004 and 2008 or a decision by OPEC to reverse the current production cuts of heavy and medium grades could cause light-heavy crude differentials to widen, at

least on a dollar-per-barrel basis. On the other hand the large increase in complex refinery capacity throughout the world could soak up much of this increased OPEC production. This would potentially end the historical correlation between higher OPEC crude production and wider light-heavy spreads.

STRATEGIC IMPLICATIONS FOR OIL COMPANIES

A narrower light-heavy crude price differential presents several implications for US refiners for both supply and investments.

- **Wait and see for upgrading investment.** The most obvious strategic implication is to delay additional investment in complex refining capacity until market conditions support a more sustained widening of the light-heavy differential. Indeed, already new coking capacity has been either delayed or canceled, and this trend is likely to continue. It appears reasonable to focus budgets on other improvements until a clearer picture of the supply-demand situation emerges. The only caveat would be if weak demand for coking units drives down their costs significantly, allowing a refiner to build one relatively cheaply over the next several years. Potentially such a refiner could be well placed once the market improves. However, IHS CERA's view is that downstream costs have already bottomed out in the wake of the Great Recession.*

- **Secure heavy feedstock for large, efficient complex refineries.** There is likely to be no price advantage in acquiring heavy crude supply on a term basis (one to five years), since today's crude producers would want to "lock in" the narrow light-heavy differential in today's market. However, the newest, most efficient complex refiners in the market are likely to have slightly better margins than their competitors. Therefore, ensuring that their refineries are filled could make a substantial difference in profit, and therefore term deals could still be warranted.

- **Secure a refining home for heavy crude producers.** Heavy crude is often the marginal barrel. Therefore producers of these grades may consider securing long-term agreements with complex refiners at a light-heavy differential somewhat weaker than in today's market. This could be a relatively small price to pay for guaranteed demand for their product over the longer term when light-heavy spreads may not be as favorable to heavy crude producers.

- **Run a lighter feedstock mix for smaller, less efficient complex refiners.** Smaller, less efficient complex refiners may find it most economical to process a lighter crude mix until the light-heavy differential widens. However, these refiners would have to settle at running at partial capacity, since a lighter crude slate would not fill up all conversion units in the plant.

- **Run more residual fuel oil to fill conversion units.** Smaller complex refineries may also consider importing and processing straight-run residual fuel oil, which might provide a profitable alternative to a waning medium crude supply. This is already a common practice in Europe and in some refineries in the United States. If such a

*See the IHS CERA Special Report *Capital Costs Analysis Forum Downstream: Third Quarter 2009 Market Review.*

trend grows, however, it would increase demand for residual fuel oil and keep added pressure on the price of heavy crudes. If residual fuel oil becomes too expensive, the smaller complex refiner would need to revert to the strategy of running a lighter crude mix. ■