Notes at the Margin

PKVerleger LLC

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THE PROMPT (HOARDING) PREMIUMS
THE DELTA HEDGING IMPACT ON OIL PRICES
CALIFORNIA'S EV DEPRESSION OF GASOLINE USE

This *Notes at the Margin* addresses three topics. The prompt premiums refiners and consumers are paying for crude oil, gasoline, and distillate are the primary focus. We estimate that the prompt (or hoarding) premiums have added $12 per barrel to the price of Brent, $12 per barrel to the price of WTI, $250 per metric ton to the price of gasoil, $0.10 per gallon to the price of gasoline, and $0.80 to the price of diesel or low-sulfur distillate. This discussion begins on page 6.

These premiums are vulnerable to a large release of strategic stocks, although we deem such a release unlikely because energy policy officials lack the market understanding found at central banks.

We begin, though, by examining the impact of changes in the number of futures held to remain delta neutral on crude oil prices. The data reveal that the R^2 in a regression of the change in the price of Brent futures and the change in the number of contracts required to remain delta neutral is 0.96. It drops off a little for the June and December futures contract but remains high.

Now, as we note below, the sample is small. We will continue to follow the evolution of the June and December contacts. The evidence, though, is that Javier Blas was correct when he wrote that "Wall Street was about to take the oil market on a wild party." It is clear today that the increase in price volatility can be attributed to the gamblers playing at the commodity casino's oil table.

Futures exchanges will transition from trading May 2022 options to June 2022 options in the next week. The shift may increase the activity associated with options hedging because the June futures market is twice the size of the May market, and volatility could rise in concert.

The delta hedging discussion begins on page 2.

The final item in our report is our analysis of California and Texas gasoline consumption in which we compare changes in use from one month to the next with changes in vehicle miles traveled. The exercise suggests that the relationship that held in California from 2013 to 2018 has broken recently, possibly due to the wide adoption of electric vehicles (EVs) in the state. No such change took place in Texas. Our conclusion is that the purchase and use of EVs

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cut gasoline use in California by around seventeen percent from the levels that would have been consumed based on miles traveled.

Delta Hedging and Oil Prices

Bloomberg's Javier Blas alerted the world to the increased importance of crude oil call options when he wrote, on January 19, that Wall Street would be taking oil out to a wild party.[1] We have quoted his opening paragraph more than once and repeat it here:

> Supply and demand fundamentals drive oil prices. Things like OPEC+ production plans and U.S. driving patterns matter the most — until they don't. That's when the wizardry of Wall Street takes over, giving prices a push up or down beyond what the physical fundamentals warrant.

Over the last two months, we have offered various cuts of data on the number of calls outstanding at different strike levels. More recently, we began to calculate the number of futures contracts the institutions writing the calls would need to hold for the May, June, and December futures contracts to stay delta neutral. While the computation is time-consuming, it provides an indication of the hedging pressure on prices: when prices rise, the writers of calls **must** buy, whereas when prices fall, they **can** sell. Blas, who dubbed the calls "lottery tickets," explained the upward process:

> As prices rise toward the value of the call options contracts, the banks that sold the lottery tickets will find themselves on the wrong side of a trade. They are, in all but name, short in a rising market. So they need to protect themselves, and the only way to do so is going long by buying futures. As they do, they risk creating a catch-22 situation: Oil prices rise, banks buy more futures, which trigger further price rises, which commands more buying. It is a situation called gamma, in the jargon of the options market. The oil market has faced similar conditions before, both to the upside and downside

What Blas did not say—and may not have known—is that a one-for-one relationship exists between the buying and selling and the move in prices. We show this relationship here in Figure 1 (page 3).

Figure 1 presents our calculated results for call options on the May Brent futures contact, comparing the change in the futures settlement price from the prior day to the change in how many contracts the financial institutions needed to buy or sell in response. For the period examined (March 4 to March 24), the daily price changes range over $25 per barrel. On one day, prices fell by $16.82. On another day, they rose by $8.93. Over the same period, the largest one-day increase in the required futures purchases was almost twenty-six thousand contracts, while the largest decline was three thousand contracts.

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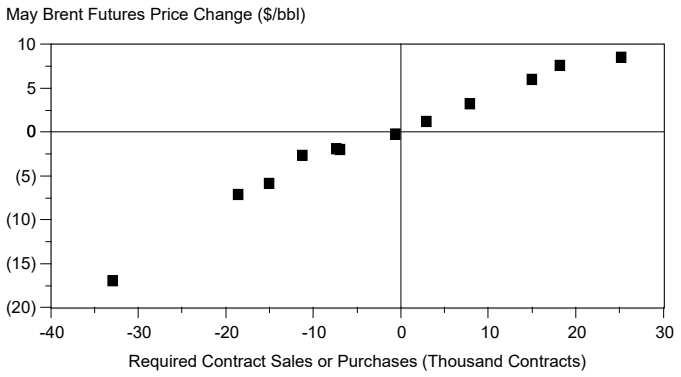
[1] *Javier Blas, "Wall Street Is About to Take Oil Out to a Wild Party," Bloomberg, January 19, 2022 [https://tinyurl.com/2p8wpcu4].*

The scatter diagram speaks for itself. There seems to be a clear linkage between price changes and the move in open interest.

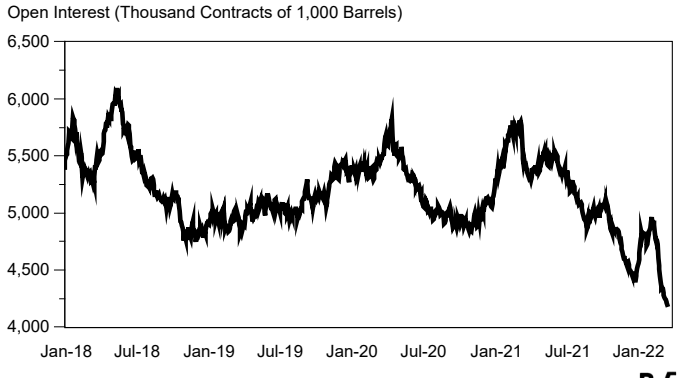
Figure 1
Change in May Brent Futures Settlement Price vs. Number of Contracts Call Writers Must Buy or Sell to Stay Delta Neutral, March 4 to March 24



Source: ICE; PKVerleger LLC.

Fundamentals clearly drive the relationship. News that might depress prices will provoke some selling by traders. The computers managing options "books" then take over, magnifying the changes, as Blas noted. Two factors explain the magnification. The first is the large overhang of call options. As Table 1 (page 4) shows, call options in the May futures contract with strike prices above $90 per barrel account for a significant portion of open interest. Indeed, on May 24, the InterContinental Exchange reported that 162,688 contracts in May futures were open. On the same date, 171,844 calls with strike prices above $90 were open, while the delta and gamma hedging models—the "Greek Geek Models" or GGM as we call them—required the institutions writing calls to be long 82,466 futures contracts.

Figure 2
Total Open Interest in the Three Primary Crude Contracts, 2018 to 2022



Source: CME; ICE.

The overall decline in open interest in futures contracts is the second factor increasing the influence of options hedging on oil prices. Figure 2 above traces the daily change in open interest in the CME WTI and ICE WTI and Brent futures contracts from 2018 to the present. The total fell to its lowest level for the period on Thursday, March 24.

Executives from trading companies attribute the decrease in open interest to the greater volatility for all energy products but especially European natural gas. The higher volatility has forced futures exchanges to boost margin requirements. Even large trading companies have had to cut positions because they cannot raise the margin amounts required to hold them.

Table 1. Settlement Price, Open Interest (OI) in Futures, Open Interest in Calls with Strike Prices >$90/bbl, and Futures Contracts Required to Remain Delta Neutral for Brent May, June, and December 2022 Futures Contracts (Contracts)

	May 2022 Contract				June 2022 Contract				December 2022 Contract			
Date	Settle ($/bbl)	OI in Futures	OI in Calls >$90	Delta Futures Re-quired	Settle ($/bbl)	OI in Futures	OI in Calls >$90	Delta Futures Re-quired	Settle ($/bbl)	OI in Futures	OI in Calls >$90	Delta Futures Re-quired
Mar 3	110.46	408,473	147,439	77,613	106.54	342,251	216,174	108,251	93.46	214,639	301,827	92,987
Mar 4	118.11	395,912	148,898	92,298	114.34	342,075	221,272	128,514	100.74	217,884	306,976	117,533
Mar 7	123.21	371,643	157,701	99,398	118.87	348,139	216,443	134,759	103.00	207,840	298,965	121,553
Mar 8	127.98	346,114	158,986	106,362	123.48	354,140	213,561	143,660	104.33	213,826	282,840	117,467
Mar 9	111.14	319,668	153,740	73,369	107.03	361,874	212,095	105,322	92.15	202,973	279,407	86,519
Mar 10	109.33	291,068	151,890	65,985	105.43	374,064	220,806	101,482	92.38	203,656	280,064	88,257
Mar 11	112.67	258,950	152,303	73,880	109.10	393,683	227,281	114,336	95.96	202,884	278,197	99,338
Mar 14	106.90	248,236	149,255	58,793	103.40	390,086	227,335	95,582	91.96	204,141	277,202	91,016
Mar 15	99.91	236,360	148,650	40,152	97.58	387,682	225,707	77,272	89.46	204,356	280,869	88,535
Mar 16	98.02	222,194	146,044	33,202	95.64	391,788	229,493	70,121	87.53	205,406	282,843	80,852
Mar 17	106.64	216,650	158,705	58,376	103.56	399,745	229,737	95,950	93.04	204,734	285,986	97,777
Mar 18	107.93	208,594	156,749	61,245	105.07	411,906	243,973	104,143	94.35	205,708	291,319	100,883
Mar 21	115.62	197,616	156,632	79,423	111.92	425,925	254,067	125,048	98.47	200,434	283,117	105,833
Mar 22	115.48	187,166	156,986	78,784	111.83	418,789	252,751	123,805	98.19	198,256	285,430	105,148
Mar 23	121.60	174,767	172,775	93,770	117.75	415,374	268,102	143,123	101.22	196,511	268,102	106,265
Mar 24	119.03	162,668	171,844	82,446	115.30	414,947	272,452	135,372	99.14	193,207	272,452	102,038

Source: ICE; PKVerleger LLC.

The need for capital has led energy trading firms to call on central banks to provide financial support, as *Financial Times* reported:

> Top energy market executives spoke to the Bank of England and European Central Bank this week to express alarm at large spikes in commodity futures prices, which are hampering risk management and threatening the smooth flow of physical assets around the world.[2]

FT added that the central bankers listened politely and were "keen to understand how to ease strains in futures markets." However, energy derivatives are not that important. The chair of the Commodity Futures Trading Commission noted blithely, "It's helpful that we talk about it [the need for liquidity] so we can collectively work to mitigate the risks that might arise."

The same article quoted a more-concerned Trafigura's executive chair: "We do need some form of liquidity to come back into the marketplace.'" Apparently, it will not come from central banks. No news of any interest on their part emerged during a conference on commodity markets last week in Switzerland.

Absent central bank intervention, the traders, private banks, and commodity exchanges will have to deal with the volatility in oil and other commodities on their own. One action they

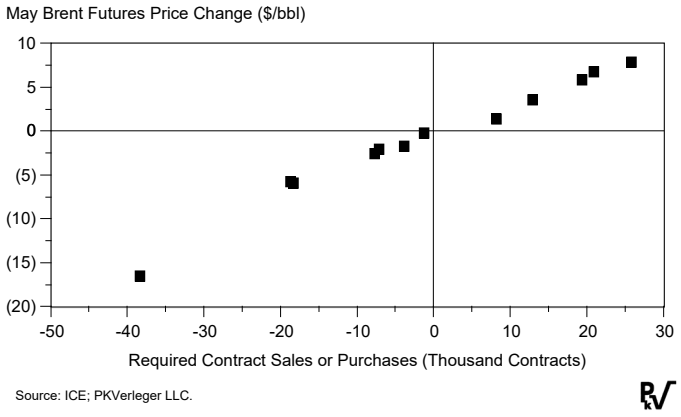
[2] *Philip Stafford, Claire Jones, Neil Hume, and Martin Arnold, "Central banks unlikely to offer immediate support to energy markets,"* Financial Times, *March 22, 2022 [https://tinyurl.com/yc2tcfcv].*

might consider is encouraging the exchanges to limit the buying and selling of call derivatives. This might reduce activity. As Blas wrote, the contracts are “a cheap way to bet on surging prices in the future.” Those wagers are now threatening the large trading companies financially.

Oil price volatility will rise next week if the exchanges do nothing. Above we noted the linear relationship between the changes in the number of contracts required to hedge a one-dollar change in the May futures contract price and the May Brent futures settlement prices. The statistics reveal that a ten-thousand-contract change in the number of contracts bought or sold to remain delta neutral shifted futures prices by $4 per barrel. The situation is a little more extreme for the June Brent contract.

The June Brent options contract will become the spot (or expiring) options contract next week. Figure 3 shows the relationship between the number of contracts that need to be bought or sold to remain delta neutral and the change in price. The relationship is the same as the relationship for the May contract. However, the results indicate that a ten-thousand-contract change in options bought or sold would shift the price of the June futures prices by $5 per barrel, not $4. Unless something is done, markets will become more volatile.

Figure 3
Change in June Brent Futures Settlement Price vs. Number of Contracts Call Writers Must Buy or Sell to Stay Delta Neutral, March 4 to March 24



Source: ICE; PKVerleger LLC.

The issue of increased volatility also depends on the role of the June contract, which, at this point, is uncertain. Traditionally, the December and June oil futures contracts are the most important for the market because traders tend to congregate in the two. Indeed, open interest in the June and December contracts is roughly double the open interest in the ten other months for both Brent and WTI. Options activity is also greater in these contracts. In the coming days, we will learn whether the June contract’s greater activity will increase or decrease price volatility.

Measures to raise the cost of the “Blas lottery” tickets would almost certainly reduce the activity in options and result in lower prices. This is something the large traders and the exchanges may wish to address.

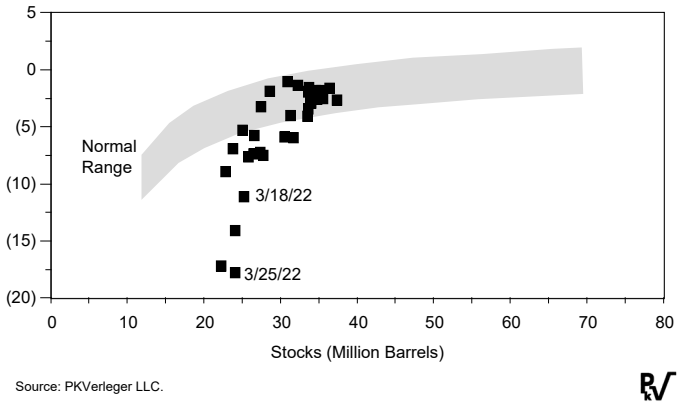
Conserving Inventories, a.k.a. Hoarding

> If there is a shortage of supply capable of being remedied in six months but not at once, then the spot price can rise above the forward price, which is only limited by the unwillingness of the buyer to pay the higher spot price rather than postpone the date of his purchase.[3]

This sentence written by John Maynard Keynes has motivated thousands of papers on commodity markets, many with a focus on "normal backwardation." These analyses led others, such as Holbrook Working, to look at the relationship between price spreads (generally in backwardation) and inventories. The empirical results go by the name "supply of storage." As Jeffrey Williams noted in a paper years ago, a nonlinear relationship exists for almost all commodities. We show that relationship in Figure 4, a graph we often include in our reports.

Figure 4 presents the supply of storage for crude stored in Cushing, Oklahoma, the delivery point for the CME WTI futures contract. The shaded area shows the normal range developed using standard statistical techniques. The normal range measures the premium (measured as a negative number by convention) that a buyer would need to pay to obtain a barrel of crude now rather than wait six months.

Figure 4
Supply-of-Storage Curve for Crude Stored in Cushing, 2004 to 2022



Source: PKVerleger LLC.

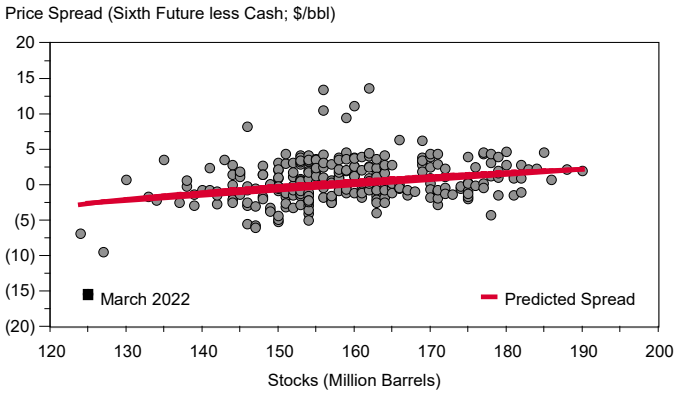
Given current inventory levels, based on the historical relationship, a buyer would expect to pay a premium of around $6 per barrel to obtain crude for immediate delivery rather than wait six months.

The historical relationship does not hold today. The most recent observation, March 25, is well below the normal range. Instead of paying $6 per barrel for immediate delivery relative to six months later, the buyer must pay $18. The $12 difference is the "hoarding premium." Buyers must pay it for WTI because those holding stocks are uncertain about the availability of future supply.

[3] *J.M. Keynes, "A Treatise on Money; The Applied Theory of Money," 1930, in the* Collected Writings of John Maynard Keynes *(Volume 6), Donald Moggridge and Susan Howson (eds.) (London: Cambridge University Press, 1982), p. 128.*

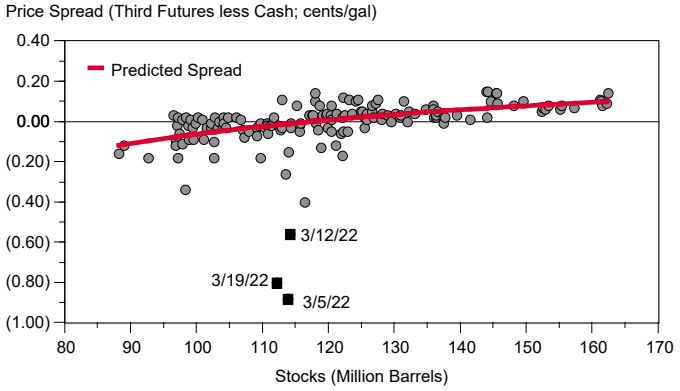
We also might call this premium the GIP or "government incompetence premium." Private inventories are low today. Future supplies are uncertain. According to the International Energy Agency, governments hold more than 1.5 billion barrels of crude oil in strategic stocks that they refuse to release. Selling a portion of these reserves would eliminate some, if not all, of the GIP. It could also reduce the trader betting on high crude prices.

Figure 5
Supply-of-Storage Curve for Brent Stored in Europe, 2000 to 2022



Source: PKVerleger LLC.

Figure 6
Distillate Fuel Oil Supply-of-Storage Curve, 1986 to 2022



Source: PKVerleger LLC.

Buyers must also pay a $12 premium to obtain prompt supplies of Brent. Figure 5 shows the supply-of-storage curve for Brent. Here, we use data on crude inventories held in Europe published by the Energy Intelligence Group. The $12 premium is clear in the graph.

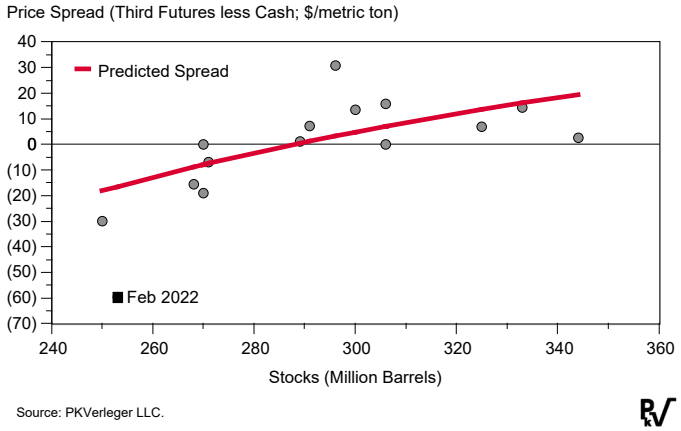
The GIP or hoarding premium for distillate fuel oil in the United States is double the premium on crude. Figure 6 shows the supply-of-storage curve for distillate fuel oil. Here, we compare US stocks to the distillate price spread calculated from the New York Mercantile Exchange weekly data. The premium for March 19, the most recent observation, was $0.78 per gallon or $32 per barrel.

The gasoil premium in Europe is similar. Figure 7 (page 8) shows a gasoil supply-of-storage curve computed from February data. The spread between the spot and six-month-forward prices in February was $60 per metric ton or $8 per barrel. It increased to $258 per metric ton, or $36 per barrel, in the most recent March observation. According to the historical data, gasoil should have been in a $20 per metric ton contango (around $3 per barrel). That means its hoarding premium is almost $40 per barrel.

Thus, gasoil and distillate consumers are paying almost $1 per gallon due to the uncertainty regarding supplies of these fuels. European and US refiners are paying a premium for crude of around $20 per barrel, which means the supply uncertainty has added $0.50 per gallon to refining margins.

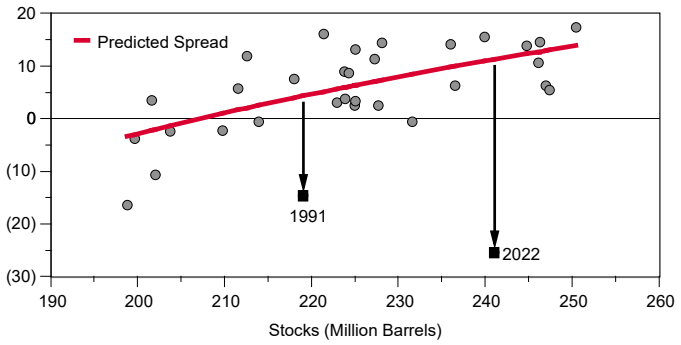
We attribute the distillate and gasoil premiums to the uncertainties created by the invasion of Ukraine and the ill-advised regulations on marine bunker fuel established by the International Maritime Organization. On many occasions, we have noted that the lack of adequate capacity to produce low-sulfur distillate and gasoil could boost their prices. These warnings have been ignored. The consequence today could be high prices of some time to come.

Figure 7
Gasoil Supply-of-Storage Curve, February Data, 2008 to 2022



Source: PKVerleger LLC.

Figure 8
Supply-of-Storage Curve for Gasoline in the United States Showing 1991 and 2022 Hoarding Premiums (Data for Mid-March, 1990 to 2022)



Source: PKVerleger LLC.

Refiners do not, however, seem to be earning a premium on gasoline. Figure 8 shows supply-of-storage data for gasoline for March. Here, we compare stock data from the US Energy Information Administration's weekly statistical report to the spot-future gasoline spread. The data exhibit two anomalies. The first occurred in 1991 after the Gulf War destruction of oil fields in Kuwait and the resulting sanctions imposed on Iraq reduced global crude oil supplies. In March of that year, buyers paid a premium of $0.11 per gallon for prompt supplies of gasoil (around $5 per barrel).

The premium today is double. It roughly equals the premium being paid for Brent crude. This implies that the higher gasoline prices in spot markets reflect only the uncertainty regarding future crude oil supply, that is, there is no uncertainty currently about gasoline supply.

Our analysis of the linkage between inventories and prices provides a way of estimating the impact of a proper release of strategic reserves. If governments announced that they would release a large portion of their stocks in the coming months, most of the hoarding premium would likely disappear, lowering crude prices by **at least $12 per barrel**. Such news would also probably cause many of Blas's bettors to cash in their lottery tickets and take profits on their calls. This profit-taking would allow the financial institutions to sell futures, which could bring futures prices down by another $10 or even $20 per barrel.

The opportunity is there for consuming-nation governments to help depress prices significantly. It is, though, one they are unlikely to take.

The failure of governments to understand the relationship between inventories, price spreads, and gambling on oil is tragic because the world's central banks are beginning to tighten interest rates. Some believe rates may rise to four or five percent by the end of the year. Many economists think a recession will follow. Some of the inflationary pressure could be removed by a substantial release from strategic crude oil stocks.

The incompetence of energy policy officials—especially those in the IEA—is a catastrophe of enormous proportions. These inept individuals are driving the developed world into recession. Worse, they may be driving many in developing nations into starvation and even death. In this respect, they will cause far more harm and hardship to the world than Vladimir Putin is causing in Ukraine.

Impact of EVs on Gasoline Consumption

The Federal Highway Administration (FHWA) released data on miles traveled in motor vehicles for states recently. These data come out monthly and now cover the period up through January 2022. At the same time, the State of California released data on taxable gasoline sales through the end of December 2021.

The data release allows us to examine the impact of electric vehicle penetration on gasoline consumption. To do this, we compared gasoline use in Texas and California using the states' data on taxable gasoline sales and the FHWA data on vehicle miles traveled (VMT).

Our interest was piqued because EV penetration has been significant in California. Our analysis shows that gasoline consumption has been depressed by perhaps seventeen percent as a result. In comparison, EV penetration in Texas has been minimal and thus EVs have had no impact on gasoline use there.

The data on EV registrations highlights the difference between the states. At the end of 2020 (the most recent data, it seems), California noted four hundred twenty-five thousand EV registrations. This was almost ten times the fifty-two thousand EVs registered in Texas.[4] The California EV registrations represented three percent of the state's 14.2 million registered

[4] *Scooter Doll, "Current EV Registrations in the US: How Does Your State Stack Up?" electrek, August 24, 2021 [https://tinyurl.com/yj3svjxk].*

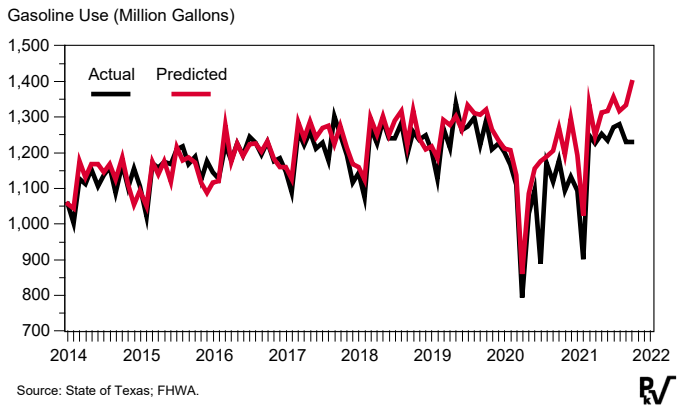
vehicles in 2020.[5] The Texas EV registrations accounted for 0.6 percent of that state's more than eight million registered vehicles.

The data suggest that California's 2020 ratio of EV registrations to total vehicle registrations was five times greater than in Texas. The California ratio likely increased over 2021.

The impact of the shift to EVs can be seen in motor fuel consumption. We modeled the data on motor fuel use as a function of VMT for both states. Our simple theory was that a good relationship should exist between fuel used and miles traveled. To remove the impact of serial correlation, we used a simple first-difference model to regress the change in motor fuel use on the change in VMT. We then performed conditional dynamic simulations of future gasoline consumption based on the change in VMT.[6]

Figure 9 shows the conditional dynamic simulation of motor fuel sales in Texas. Despite our not correcting for errors, the predicted values for gasoline consumption followed the actual values closely.

Figure 9
Actual Motor Gasoline Sales in Texas vs. Sales Projected Based on VMT, 2014 to 2021



Source: State of Texas; FHWA.

Figure 10 (page 11) displays the same information for California. Here again, the predicted values closely follow actual values from January 2013 to December 2018. After the end of 2018, though, the predicted and actual values begin to diverge. By December 2021, actual consumption is seventeen percent below predicted levels. The difference amounts to one hundred eighty thousand barrels per day and appears to be growing.

We attribute the divergence to the growing penetration of EVs in California and consumers choosing to use EVs rather than gasoline, diesel, or natural-gas-powered vehicles wherever possible.

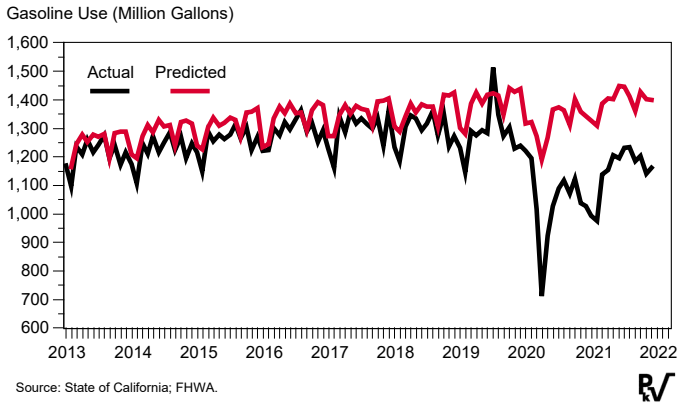
[5] *"Automobile registrations in the United States in 2020, by state," Statista [https://tinyurl.com/5n7277a6].*

[6] *The regression is based on the following simple formula:*

$\Delta Gas_t = \alpha + \beta \Delta VMT_t + \varepsilon_t$ *where Gas is the taxable volume of gasoline sales in month t and VMT represents the vehicle miles traveled in month t. We then simulated* $Pgase_t = Pgas_{t-1} + \boldsymbol{\alpha} + \boldsymbol{\beta} \Delta VMT_t$ *where the estimated values of α and β are in bold.*

A survey published a year ago by *CarGurus* provides a basis for this last conclusion.[7] A telling chart in the survey noted that respondents would be much more willing to consider buying an EV if gasoline prices were high. Less than ten percent of the respondents would consider changing if gasoline prices were less than $3 per gallon. The number jumped to almost sixty percent, though, if gasoline prices were $5 per gallon.

Figure 10
Actual Motor Gasoline Sales in California vs. Sales Projected Based on VMT, 2013 to 2021



Source: State of California; FHWA.

The recent gasoline price increase has boosted the delivery wait for Tesla's Model 3 (without the $12,000 self-driving option) to six months. Wait times for other models are now around three months.[8]

The surveys of vehicle use in 2022 that will come out in one or two years will probably show that the sharp rise in gasoline prices during the spring of 2022 accelerated EV adoptions in the United States, Canada, and Europe. The surveys will also likely show that EVs were used intensively around towns but much less on longer trips.

The data from California make clear that EV penetration will depress gasoline use. The effect will grow quickly if fuel prices remain high, especially if the auto industry can meet the demand for the vehicles.

Markets

Markets remained very tight. The most interesting statistic this week may come from the WTI market, where oil for April delivery continued to trade on March 25 in the physical market even though the April futures contract had expired. Oil in the physical market traded for the same price as the April futures contract before the expiry, a normal feature of the WTI market, and $2 per barrel above the May futures. By Friday, the difference had increased by more than a dollar as buyers scrambled for physical volumes in Cushing, where stocks are low.

The jump in the cash price further depressed excess returns to storage in Cushing, as can be seen from Table 2 (page 12). For example, the excess returns for May dropped from

[7] *"Electric Vehicle Sentiment Survey, United States," CarGurus, March 2021 [https://tinyurl.com/2se9pbmv].*

[8] *Jim Holder, "Electric Car Waiting Times Revealed," What Car? [https://tinyurl.com/5dvbsme4].*

negative thirteen percent at annual rates to negative twenty percent. The May excess returns to storage in the Brent market, in contrast, became less negative.

Distillate and gasoil excess returns remain extraordinarily depressed. During the week, traders gathered in Switzerland for *Financial Times*' annual commodity conference warned that diesel supplies might need to be rationed in Europe this summer. The difficulty occurs because around fifteen percent of Europe's diesel supply comes from Russia.[9] Further increased demand has come from the implementation of the IMO low-sulfur program. The result is the very high premium being paid for the product relative to crude and relative to forward quotes.

The word that describes markets today seems to be "unstable."

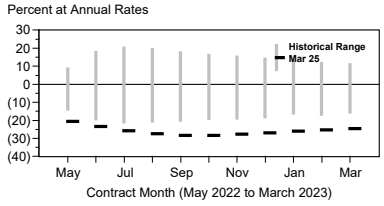
Table 2. Excess Returns to Storage on March 18 and March 25, 2022, for Two Crudes and Two Distillates (Percent at Annual Rates)

	WTI Cushing – No Storage Costs on Mar 25	Brent at Sullom Voe – No Storage Costs on Mar 25	WTI Cushing – No Storage Costs on Mar 18	Brent at Sullom Voe – No Storage Costs on Mar 18	WTI Six Prior Year Average	Brent Six Prior Year Average
May	-20.7	-21.8	-13.2	-28.8	14.7	26.4
Jun	-23.5	-24.6	-18.6	-28.5	16.9	24.3
Jul	-25.7	-27.3	-21.1	-28.0	15.7	21.6
Aug	-27.3	-28.2	-22.4	-26.9	14.0	18.9
Sep	-28.2	-28.1	-22.7	-25.7	12.4	16.6
Oct	-28.3	-27.8	-22.5	-24.7	11.6	14.5
Nov	-27.6	-27.1	-21.8	-23.7	10.3	12.9
Dec	-26.8	-26.5	-21.3	-22.9	8.7	11.3
Jan	-26.0	-25.8	-20.6	-22.1	7.8	10.1
Feb	-25.2	-25.1	-20.1	-21.3	7.1	9.0
Mar	-24.6	-24.4	-19.7	-20.7	1.7	8.3
Distillate Markets	New York Mar 25	ARA Mar 25	New York Mar 18	ARA Mar 18	New York Six Prior Year Average	ARA Six Prior Years Average
Apr	-36.4	-71.5	-28.2	-59.0	4.9	37.0
May	-46.0	-62.2	-32.4	-57.4	3.9	8.5
Jun	-47.0	-59.8	-32.4	-55.1	4.2	7.4
Jul	-44.9	-56.5	-30.3	-51.6	4.9	7.5
Aug	-41.9	-52.5	-28.6	-47.7	5.6	5.5
Sep	-38.2	-48.4	-27.0	-43.4	6.1	5.9
Oct	-35.3	-45.0	-26.0	-39.8	6.6	6.0

Source: PKVerleger LLC.

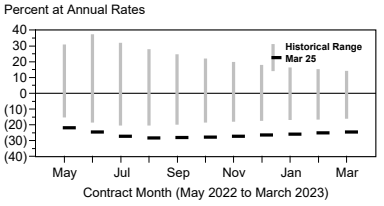
[9] *Neil Hume, Harry Dempsey, and Eva Szalay, "Traders warn of looming global diesel shortage,"* Financial Times, *March 22, 2022 [https://tinyurl.com/53huce54].*

Excess Returns to Storage for WTI — March 25 Returns vs. Historical Range



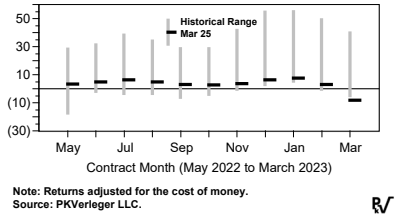
Note: Returns adjusted for the cost of money.
Source: PKVerleger LLC.

Excess Returns to Storage for Brent — March 25 Returns vs. Historical Range



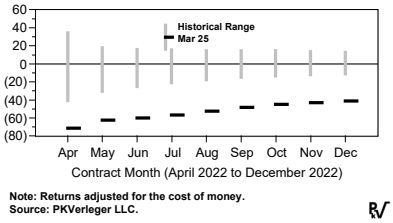
Note: Returns adjusted for the cost of money.
Source: PKVerleger LLC.

Excess Returns to Storage for Natural Gas — March 25 Returns vs. Historical Range



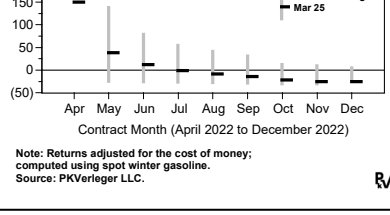
Note: Returns adjusted for the cost of money.
Source: PKVerleger LLC.

Excess Returns to Storage for Gasoil — March 25 Returns vs. Historical Range



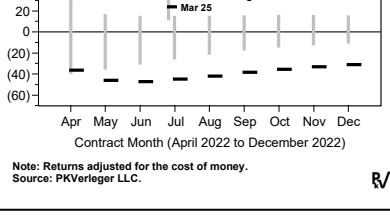
Note: Returns adjusted for the cost of money.
Source: PKVerleger LLC.

Excess Returns to Storage for Gasoline — March 25 Returns vs. Historical Range



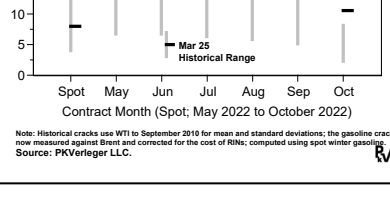
Note: Returns adjusted for the cost of money; computed using spot winter gasoline.
Source: PKVerleger LLC.

Excess Returns to Storage for Heating Oil — March 25 Returns vs. Historical Range



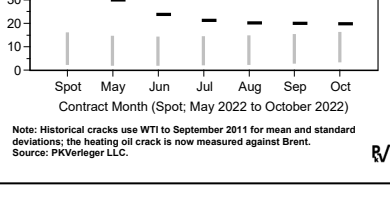
Note: Returns adjusted for the cost of money.
Source: PKVerleger LLC.

Refining Margins for Gasoline — March 25 Margins vs. Historical Range



Note: Historical cracks use WTI to September 2010 for mean and standard deviations; the gasoline crack is now measured against Brent and corrected for the cost of RINs; computed using spot winter gasoline.
Source: PKVerleger LLC.

Refining Margins for Heating Oil — March 25 Margins vs. Historical Range



Note: Historical cracks use WTI to September 2011 for mean and standard deviations; the heating oil crack is now measured against Brent.
Source: PKVerleger LLC.

Excess Returns to Storage for Crude, Products, and Natural Gas — Last Week of March vs. Prior Week and Last Week of March in Prior Years (Percent at Annual Rates)

	Current	Last Week	2021	2020	2019	2018	2017
Gasoline							
May	38.4	31.0	37.4	377.9	21.3	67.2	11.7
June	12.1	6.7	21.1	249.1	6.2	36.4	11.2
July	-1.1	-4.3	12.3	192.1	0.5	23.0	7.3
August	-8.8	-10.1	6.9	159.2	-3.0	14.5	2.9
September	-13.7	-13.8	2.7	134.5	-5.7	8.4	-0.9
Distillate							
April	-36.4	-28.2	20.1	-3.1	2.3	5.4	8.1
May	-46.0	-32.4	9.1	2.2	0.7	3.1	6.6
June	-47.0	-32.4	5.2	6.9	0.5	2.2	6.2
July	-44.9	-30.3	3.4	11.2	0.9	1.4	6.1
August	-41.9	-28.6	2.4	13.9	1.4	0.9	6.3
Gasoil							
April	-71.5	-59.0	12.9	-3.3	6.4	180.5	1.7
May	-62.2	-57.4	8.1	5.7	2.5	13.2	2.5
June	-59.8	-55.1	6.3	13.8	1.9	2.0	2.6
July	-56.5	-51.6	5.1	19.2	2.0	-1.5	2.7
August	-52.5	-47.7	3.5	21.6	2.1	-2.4	2.9
WTI							
May	-20.7	-13.2	0.9	9.7	-1.5	-2.2	7.9
June	-23.5	-18.6	-1.2	59.3	-0.3	-2.7	9.6
July	-25.7	-21.1	-2.9	74.7	0.4	-4.2	9.2
August	-27.3	-22.4	-4.3	72.8	0.7	-5.7	8.4
September	-28.2	-22.7	-5.2	67.3	0.6	-6.9	7.6
Brent							
May	-21.8	-28.8	10.0	77.9	6.9	24.6	8.4
June	-24.6	-28.5	4.5	98.2	1.1	9.6	6.3
July	-27.3	-28.0	0.8	96.8	-1.2	4.4	5.9
August	-28.2	-26.9	-1.0	89.2	-2.3	1.3	5.5
September	-28.1	-25.7	-2.3	80.8	-2.8	-0.6	4.9
Natural Gas							
June	5.1	5.7	21.4	47.4	10.7	6.7	18.5
July	6.4	7.3	23.7	78.6	16.1	11.7	20.5
August	5.0	5.9	19.9	66.6	14.0	10.5	18.0
September	3.2	4.0	15.0	54.7	9.9	5.5	13.7
October	2.8	3.8	13.7	53.5	11.9	5.2	12.2

Note: “Current” = March 25, 2022. All returns to storage are adjusted for the cost of money.

Source: PKVerleger LLC.

Open Interest for Crude, Products, and Natural Gas — Last Week of March vs. Prior Week and Last Week of March in Prior Years (Number of Contracts)

	Current	Last Week	2021	2020	2019	2018	2017
Gasoline							
Total	290,548	289,602	397,550	364,232	432,683	439,827	398,667
April	29,387	50,846	56,028	50,767	45,605	45,439	35,486
May	106,729	93,382	131,784	102,593	142,263	159,517	126,979
June	41,823	35,266	59,657	45,758	72,764	65,038	67,561
July	31,204	28,762	31,852	29,773	43,214	44,462	35,918
Distillate							
Total	229,160	240,524	447,168	400,975	391,833	396,223	420,752
April	36,211	46,362	92,747	74,933	63,545	66,287	77,539
May	54,456	52,794	93,734	84,102	96,575	95,949	91,855
June	34,184	35,496	70,965	57,790	64,387	55,280	66,157
July	16,723	15,752	29,024	30,684	29,014	35,922	33,503
Gasoil							
Total	518,851	515,632	963,648	859,498	908,119	973,635	895,908
April	66,697	81,885	127,245	126,494	122,098	102,039	157,217
May	120,176	112,034	157,924	145,780	148,987	198,234	111,199
June	69,107	65,811	127,242	110,385	122,341	148,603	136,438
July	39,493	36,009	59,966	55,092	51,997	71,031	76,069
WTI							
Total	1,794,775	1,797,129	2,080,268	2,425,668	2,124,117	1,951,375	2,509,804
May	287,075	276,654	434,709	529,246	434,375	496,529	632,705
June	188,184	180,417	330,644	270,527	262,064	364,465	328,361
July	107,681	100,650	171,535	158,722	153,454	155,872	137,885
August	60,114	54,007	122,033	89,305	110,795	116,637	93,904
Brent							
Total	1,906,527	1,925,299	2,652,216	2,649,248	2,417,813	2,419,369	2,463,855
May	162,668	208,594	323,686	225,293	257,580	59,443	272,049
June	414,947	411,906	495,623	480,816	532,816	621,315	527,148
July	236,168	211,780	318,527	297,591	228,497	278,856	300,405
August	104,824	105,529	148,576	140,042	132,312	147,531	126,632
Natural Gas							
Total	1,095,248	1,091,208	1,205,632	1,209,453	1,156,469	1,427,289	1,355,714
April	19,304	64,068	16,608	2,937	35,683	68,117	42,712
May	232,144	214,813	284,888	350,414	273,006	400,613	295,033
June	72,212	68,859	106,003	94,115	102,842	98,158	127,489
July	93,184	88,044	99,617	118,467	105,530	158,313	127,343

Note: “Current” = March 25, 2022.

Source: PKVerleger LLC.

Gasoline Cracks – Last Week of March vs. Prior Week, Prior Month, and Last Week of March in Prior Years ($/bbl)

	Current	Last Week	Last Month	2021	2020	2019	2018	2017	30-Year Average
Spot	7.99	10.37	9.01	8.68	-4.12	10.85	14.89	13.75	9.04
May	18.47	21.70	17.32	12.38	-0.38	10.02	12.58	14.55	11.97
June	18.84	20.94	20.04	12.26	-1.28	10.22	13.70	14.59	11.53
July	18.68	19.66	20.39	12.09	-2.21	9.92	13.95	14.10	10.88
August	17.79	18.19	19.83	11.55	-2.81	9.39	13.77	13.31	10.14
September	16.44	16.50	18.80	10.76	-3.08	8.62	13.23	12.25	9.09
October	10.62	10.50	17.39	5.97	-6.34	3.45	7.99	6.78	5.06
Average	15.55	16.84	17.54	10.53	-2.89	8.93	12.87	12.76	9.67

Note: “Current” = March 25, 2022. Gasoline cracks measured against Brent from 2010 with RIN cost removed.

Source: PKVerleger LLC.

Heating Oil Cracks – Last Week of March vs. Prior Week, Prior Month, and Last Week of March in Prior Years ($/bbl)

	Current	Last Week	Last Month	2021	2020	2019	2018	2017	30-Year Average
Spot	45.30	36.86	13.22	5.35	21.90	13.73	15.45	9.73	9.98
May	29.92	27.32	12.58	4.23	17.83	13.29	12.31	9.03	8.94
June	23.74	22.75	13.84	4.48	15.39	14.24	13.16	9.23	8.80
July	21.29	20.20	14.27	5.07	13.28	14.83	13.61	9.35	8.98
August	20.14	18.95	14.45	5.58	11.99	15.42	14.06	9.59	9.31
September	19.93	18.88	14.80	6.17	11.53	16.09	14.57	9.99	9.85
October	19.80	18.98	15.56	6.78	11.41	16.70	15.01	10.39	10.62
Average	25.73	23.42	14.10	5.38	14.76	14.90	14.02	9.62	9.50

Note: “Current” = March 25, 2022. Heating oil cracks measured against Brent from 2011.

Source: PKVerleger LLC.