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Commodity Price Mechanisms

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Basics

- “Derivative”=financial contract in which the payoff is derived from the value of some “underlying”
- EG, gold forward contract has a payoff that depends on the price of gold
- Also referred to as a “contingent claim” because payoff is contingent on something else
- “Something else” could be a price, or an event (e.g., default, temperature, government unemployment report, movie box office)



Forwards

- The forward contract is the most basic derivative
- Delivery settled: contractual *obligation* to buy or sell a specified underlying instrument at a specific date
- Cash Settled: contractual obligation to exchange cash flows per a formula
- Parties agree to price at initiation of agreement, but no money changes hands (under a standard forward) when deal is struck



Futures

- A futures contract is a type of forward contract
- Nomenclature is imprecise, but usually the term “futures” is used to refer to a contract that is traded on exchange (vice OTC) and cleared
- But . . . Especially in energy (and soon by regulatory fiat for most everything) OTC contracts are/will be cleared
- Also, the term “futures” pre-dates the introduction of clearing in the late-19th and early 20th centuries



Exchange Trading vs. OTC

- Main distinction is between exchange trading and OTC
- Exchanges standardize all relevant terms: parties need negotiate only price and quantity
- OTC permits customization
- That said, most OTC contracts (measured in volumes of trade) are highly standardized, and often mirror exchange traded contract terms (e.g., NYMEX lookalike swaps)



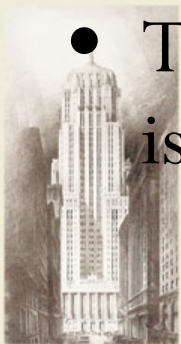
Swaps

- Swaps are essentially bundles of cash settled forward contracts in which parties exchange (“swap”) cash flows pursuant to a formula
- Example: Ap-Oct natural gas swap
- Contract sets: (a) notional size, (b) payment frequency, (c) payment formula (i.e., price or price index used to determine cash flows)
- Bullet swap is a swap where cash flows are exchanged on a single date—essentially a synonym for a cash settled forward



Uses of Forwards and Swaps

- Like all derivatives, forwards & swaps are *risk transfer mechanisms*
- Hedgers use contracts to reduce risk exposure (e.g., owner of a cargo of Nigerian crude sells WTI futures as a hedge)
- Speculators use them to increase risk exposure in anticipation of earning a profit
- That said, the line between speculation and hedging is hazy



Delivery vs. Cash Settlement

- Most exchange-traded commodity contracts require delivery if held to expiration
- Most OTC contracts are cash settled
- Very few delivery-settled contracts actually result in delivery because most hedgers are “cross hedgers” and most speculators do not want to hold the phyz
- Hedgers and specs liquidate/roll positions prior to expiration



Delivery is Still Important

- Delivery-settled contracts *can* be used to transfer ownership, but that's not the main role of the delivery mechanism
- Delivery ties together cash and futures prices at expiration: “convergence”
- In this way, delivery ensures that futures prices reflect physical market realities at expiration: the expectation that this convergence will occur ensures that futures prices reflect physical market realities prior to expiration



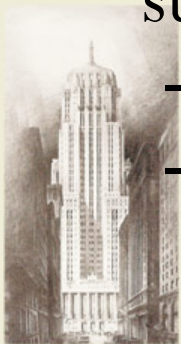
Cash Settlement

- Cash settlement is another way of tying forward and physical markets
- Many cash settled commodity forwards are settled based on prices of delivery settled futures (e.g., NYMEX LD NG swaps)
- Others are based on indices
- EG HSC forwards. Settled against average HSC prices reported during “bid week”



More on Cash Settlement

- Quality of index prices is highly uncertain: illiquidity/lack of trading, incomplete reporting, fraudulent reporting
- Index prices are best when they are based on transactions prices from transparent markets
 - Stock index futures
 - Live hogs in the US
- Index prices more problematic when they are based on surveys or indications
 - Platts prices
 - Libor



Some Common Cash Settled Contracts

- Monthly forwards
- Basis swaps (e.g., HSC-NYMEX HH)
- Gas daily swap (swap average of daily prices during flow month for monthly bid week price for that month)
- Many crude oil swaps (other than those based on Brent or WTI)



EFPs, EFRs, and EOOs

- Exchange for Physical (EFP, *ex pit*): privately negotiated and simultaneous exchange of a futures position for a corresponding position in the underlying physical
- Exchange for Risk (EFR): privately negotiated and simultaneous exchange of a futures position for a corresponding Over the Counter (OTC) swap or other OTC derivative in the same or related instrument (e.g., NYMEX CL for NYMEX CL lookalike)
- Exchange of Options for Options (EOO): exchange of an Exchange option position for a corresponding OTC option position or other OTC contract with similar characteristics in the same or a related instrument



Reporting EFPs

- Both parties to the trade must have an account at a Futures Clearing Member (Clearing Member or FCM). Subsequent to the negotiation of the EFRP, details must be provided to the relevant FCM for reporting to the Exchange.



Using EFPs

- Quite useful for hedgers as a way to reduce execution risk
- EG, grain merchant short SY futures, processor in Iowa long futures
- Merchant agrees to deliver 500m bu of beans to the processor's plant. They agree to a basis price (vs. front month CBT SY futures), and the merchant delivers the beans and the short futures in exchange for the processor's long futures position
- Parties can close out their futures positions at prevailing market price
- Exchanges require actual physical transfer: will scrutinize EFPs executed by those not typically in the physical market



Trading Mechanisms

- Organized Exchanges
- OTC



Organized Exchanges

- Centralized auction markets for standardized contracts
- Exchanges standardize all contract terms (quality, quantity, delivery location)
- Parties negotiate price and trade size (number of contracts)



Auction Markets

- Old School: floor trading in “pits”
- Some floors have closed (e.g., ICE), others a shadow of their former selves (e.g., NYMEX CL pit)
- Main floor activity today is in options
- Most trading is electronic: double sided electronic auctions



Double Sided Auctions

- Buyers submit bids to buy or offers (asks) to sell
- In a computerized market, computer has algorithm that matches orders based on priority rules
- Price priority—primary priority (orders sorted by price, best prices executed first)
- Secondary priority rules vary by market/product.
Time priority, quantity priority, pro rata allocation, and hybrids are common



Centralized Markets

- Concentrate liquidity: some participants (“market makers” or “locals”) specialize in supplying liquidity by actively quoting prices
- Considerable pre-trade transparency especially in computerized markets (in floor markets, those on the floor have advantages in observing current prices)
- Post-trade transparency



Order Types

- Market order: buy or sell at best price (hit the bid, lift the offer, “sweep the book”) (liquidity demander)
- Limit order: buy or sell at a trader-specified price or better (liquidity supplier)
- Stop order: resting order that becomes a market order when the market trades at a pre-specified level (BE CAREFUL!)
- Stop limit: resting order that becomes a limit order when the market trades at a pre-specified level (BE CAREFUL, but not so careful as with a normal stop)



Clearing and Centralized Markets

- To facilitate anonymous trade in which only P & Q need be negotiated, it is necessary to standardize credit/performance risk
- Exchanges do this now through clearing
- Clearinghouse is the central counterparty—seller to every buyer, buyer to every seller
- This standardizes credit risk as everybody has the same counterparty—the CCP



Clearing

- Clearing is actually a little more complicated: CCP deals directly only with its members. Non-members must deal through members.
- Non-members do not benefit directly from CCP guarantee
- CCPs require initial margin and collect daily variation margin (marking to market)



Major Commodity Exchanges: Energy

NYMEX (part of CME Group): crude oil, refined products, natural gas

CBOT (part of CME Group): ethanol

ICE Futures: crude oil, gas oil, UK nat gas



Major Exchanges: Grains & Oilseeds

- CBOT (part of CME group): corn, soybeans, soybean oil and meal, wheat
- ICE Futures (formerly WCE): canola
- EuronextLiffe: corn, barley, rapeseed, feed wheat, milling wheat



Major Exchanges: Industrial Metals

- LME: aluminum, aluminum alloy, copper, lead, nickel, tin, zinc
- NYMEX: copper, platinum, palladium



Major Exchanges: Precious Metals

- NYMEX: gold, silver
- Dubai: gold, silver



Major Exchanges: Livestock

- CME: live cattle, feeder cattle, live hogs, pork bellies



Major Exchanges: Industrials and Fibers

- CME: plywood
- ICE Futures: cotton



Major Exchanges: Softs

- ICE Futures: coffee, sugar (world and domestic US), cocoa, orange juice
- EuronextLiffe: coffee, sugar, cocoa



OTC

- OTC markets are, for the most part, decentralized “search” markets
- Dealers typically dominate this structure
- Dealers make two sided markets for some products, negotiate prices on others
- Most end users (e.g., a hedge fund, an oil company) trade with a dealer, although end user-end user trades are possible
- Customized (“bespoke”) deals possible in OTC, but many OTC deals are highly standardized



Electronic Trading in OTC

- In energy in particular, there are electronic OTC dealing platforms
- ICE
- Sometimes referred to as an exchange, but really an electronic brokerage platform
- Parties specify counterparty credit limits
- Unlike in a true exchange, where every buyer can meet every seller, on ICE deals limited to pre-specified counterparties in pre-specified volumes



Performance Risk and OTC

- Traditionally, performance risk remained with original counterparties on OTC deals—“bilateral” deals, no central clearing
- In energy in particular, many OTC deals are cleared
- ICE Clearing
- NYMEX Clearport (EFS)
- Deals negotiated bilaterally, then given up for clearing
- Legislative proposals in US and EU will extend scope of OTC clearing
- Obligations of end users to clear, and definition of end users, currently under discussion
- Europe seems likely to be more liberal in this regard than the US



Practical Issues With Clearing

- Clearing means that you are not exposed to your original counterparty's credit
- CCPs are not immune to default, though
- Cash/working capital demands in clearing much greater: initial margin (whereas many bilateral deals extend credit), rigid variation margin (in cash)
- Mandated increases in clearing likely to lead financial institutions to increase commodity credit and to devise creative financing tools to allow cash poor end users to continue to use the markets



The Economic Functions of Derivatives Markets

- Contrary to the impression given by the popular press (and the German, Greek, Spanish, etc. governments), derivatives are not the devil's evil spawn
- They perform valuable social functions
- Risk shifting
- Price discovery



Risk Shifting

- Derivatives facilitate the efficient transfer of risk from those who bear it at a high cost to those willing to bear it at a lower cost
- Speculators perform a socially valuable function of accepting risk from those who want to shed it: consenting adults engaged in a mutually beneficial transaction
- The ying-yang of derivatives
- Can they be used to gamble: Yes!
- Can they be used to hedge: Yes!
- These functions are complementary: can't have one without the other



Price Discovery

- Information about supply and demand fundamentals dispersed among millions of individuals
- Blind men and the elephant: markets facilitate assembling the entire image
- Individuals trade on their information. Trades affect prices, and as a result, prices aggregate the dispersed information
- Price can be used to guide resource allocation



Hedging Basics

- Hedging involves exchange of flat price risk for basis risk
- The basis is the difference between the price of the thing being hedged and the price of the hedging instrument



Example

- Hedging a cargo of Urals-Med using Brent
- 5/5: U-M \$79.34, Brent \$80.89, basis=-\$1.55
- 5/26 U-M \$68.78, Brent \$71.74, basis=-\$2.96
- Would have lost \$10.56/bbl with no hedge
- Lost only \$1.41 with hedge; lost because basis moved against you (long hedger would have made money as a result of this basis move)
- Can work the other way too: basis can move in your favor



Some Takeaways

- Face some risk when you hedge, but less
- Variability of the basis determines the risk of the hedged position
- Hedges are speculations on the basis
- No hedge is perfect: all hedges are dirty
- Foregoing example assumes 1-for-1 hedge. Can sometimes do better by choosing a different hedge ratio (statistical methods)



Risk Premia

- A forward price is often described as the market's expectation of the future spot price
- NO!
- An expectation is a mathematical concept, not a traded price
- A forward price is a traded price
- A forward transaction involves the transfer of risk, so the forward price also incorporates a price of risk—the risk premium
- Risk premium = profit from speculation / cost of hedging



Theories of the Risk Premium

- “Keynesian Normal Backwardation”—nomenclature alert: this use of the term “backwardation” is different than the common market usage
- Keynes posited that hedging pressure determines the risk premium
- Hedgers want to go short: forward price must be below the expected spot price to attract specs to take the opposite side (“downward bias/upward trend”)
- If hedgers want (on net) to go long, get upward bias
- In the Keynes theory, idiosyncratic commodity price risks determine risk premia



Modifications

- Keynes's theory implicitly assumes that speculators aren't diversified
- Speculators can be diversified traders
- This means that risk premium in any commodity should be determined in same way as risk premium on other investments: by the correlation of the commodity price movements with returns on the market portfolio
- Complete integration of markets: hedging pressure doesn't matter
- Fixed costs to participation mean that idiosyncratic risks and hedging pressure can affect risk premium



Implications

- Speculation affects the risk premium (the price of RISK), not the overall level of prices (except to the extent that speculators are informed and their trades cause prices to reflect that information)
- Some hedgers don't like speculators: specifically, hedgers on the same side of the market as speculators don't like the competition



Speculation and Price Levels

- Commonly asserted that speculation distorts price *levels*
- EG, oil prices in 2006-2008
- Hard to disprove: if we knew what prices *should* be, wouldn't need markets (“knowledge problem”)
- Evidence on quantities is important



Evidence on Quantities and Speculation

- Prices send signals about how to allocate resources: distort prices, quantities should be distorted
- Driving prices up should lead to higher inventories in hands of speculators
- EG, Hunts, government price supports
- No evidence of quantity distortions during commodity price boom
- Inventories of oil fell when prices rose, and fell when prices plummeted in '08-'09
- Similar experience in metals markets



Commodity Transformations

- All commodities undergo transformations through the value chain
- Transformation in space (transportation)
- Transformation in time (storage)
- Transformation in form (processing)



Some Examples

- Power plants transform fuel into power
- Pipelines transform gas in one location to gas in another
- Storage terminals convert oil today to oil tomorrow



Complexity

- Most commodities go through numerous transformations of all 3 types
- Think of the process of transforming oil at the wellhead to gasoline at the pump
- Multiple spatial transformations (VLCC, pipeline, truck)
- Multiple physical transformations (at refinery)
- Storage at “break points”



Bottlenecks

- Every transformation process has bottlenecks
- Bottlenecks constrain the transformation process
- The tightness of these constraints can vary over time



Some Examples

- Pipeline capacity
- Transmission capacity (e.g., thermal, voltage limits)
- Refinery capacity
- Limits on rate of flow into and out of gas storage facilities (which can vary depending on type of facility)



Regulatory Bottlenecks

- Regulatory factors are an increasingly important source of bottlenecks.
- Gasoline formula regulations that vary by geographic region (e.g., Midwest)
- NOX or SOX limits (again may be geographic variation in these constraints)



Pricing

- Understanding energy pricing requires an understanding of the transformation process and the role of bottlenecks
- It also requires an understanding of the role of the price system



The Role of the Price System

- A competitive price system aggregates the information held by millions of economic actors
- Competitive prices adjust to direct resources to their highest value uses
- In particular, they adjust to reflect relative scarcity and the importance of constraints/bottlenecks



Pricing “Regimes”

- Prices may behave very differently over time, depending on how tightly constraints bind
- In general, prices are more volatile when constraints bind tightly than when they do not



The Economics of Pricing Regimes

- Very straightforward supply and demand economics explains this
- Supply is “inelastic” when constraints bind
- Binding constraints mean that it’s very costly to adjust production or consumption in response to demand and supply shocks
- In these circumstances, prices must bear the burden of adjustment



Example: Midwest Gas Pricing

- Midwest gasoline (petrol) pricing has been very controversial recently (since late-1990s)
- Several FTC investigations
- Simple supply and demand analysis can shed light on why pricing behavior has changed
- Role of environmental regulations—supply less elastic



Example: NOX Permits

- CA enacted restrictions on NOX emissions from power plants
- Due to heavy operations in summer of 2000, many plants had come close to reaching their allowed emissions
- NOX permits became a bottleneck



Derived Demand

- Demand for products further back in the marketing chain “derived from” demand for final products—e.g., demand for oil is derived from demand for gasoline, heating oil, plastics, etc.
- Bottlenecks determine how shocks upstream and downstream impact prices along the chain



Implication of Derived Demand

- The same shock (e.g., an increase in the demand for gasoline) can have a different impact on the demand for (and hence pricing of) crude oil depending on the amount of slack in refining



Spreads Price Bottlenecks

- Transmission/congestion charges price transmission bottlenecks (example: PJM)
- Price of NG transportation and storage prices pipeline and storage bottlenecks
- Crack spread
- Spark spread
- Basis



Spreads Provide Signals on Resource Allocation

- Basis prices quality/location value differences
- Locational basis will adjust to reflect changes in spatial supply and demand patterns and transportation constraints
- Example: CL basis. Basis relations in WTI (and between WTI and other crudes) have changed dramatically in recent years



WTI Basis Example

- See the Purvin Gertz report for a detailed analysis
- Example: late-2008; reduced demand, increased Canadian supply, lack of direct route from Midcontinent to Gulf resulted in sharp rise in LLS-WTI basis
- Marginal barrel determines price: where the marginal barrel comes from depends on shifting supply and demand conditions
- Seasonal and secular shifts



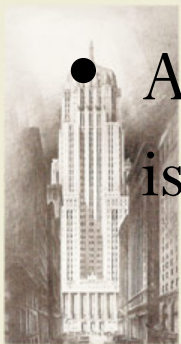
Light-Heavy Differential Example

- At the height of the oil price spike in summer, 2008, light-heavy price differentials were very wide and inventories of heavy crude were accumulating (e.g., Iran storing heavy crude in VLCCs)
- Combination of regulation-induced demand (low sulfur diesel), restrictions on supply of light sweet crude due to Nigerian disruptions, and limitations on capacity to process heavier crudes to satisfy demand for low sulfur diesel caused the differential to blow out



Contango Example

- Demand collapse in aftermath of financial crisis and inflexibility of supply response in the short run caused huge crude inventory builds, including in US Midcontinent, especially Cushing
- Storage space effectively constrained
- Contango (the implicit price of storage) on WTI blew out
- Also blew out on WTS—so it was a storage capacity issue, not a WTI/futures issue



Trading

- Spreads and pricing relationships are the essence of much commodity trading
- Trading and managing the risk of such price exposures requires an understanding of the value chain
- There is a big potential payoff to understanding the intricacies of the value chain



Suppression of Markets and Price Signals

- Sometimes (particularly in power markets, it seems) markets are missing (by accident or design) or price signals are suppressed
- Zonal pricing in power markets
- Price caps (electricity, gasoline in the bad old days)
- Absence of markets means that some bottlenecks are “free”
- People expend resources to get “free lunches”



Market Power

- The foregoing analysis has presumed that everybody is a price taker—competitive markets
- Some players may be “price makers”
- These players can influence prices—that is, they can exercise market power—by withholding output from the market



The Effects of Market Power

- Prices can spike in competitive markets
- Market power can lead to higher prices, but prices can be high without market power
- Market power sometimes hard to diagnose—not so hard at other times
- Policies that make no sense when there is no market power (e.g., price caps) may be sensible when market power exists



Market Power and Bottlenecks

- Bottlenecks can create or enhance market power
- Less competition behind bottleneck
- Midwestern gasoline redux
- Market power per se is not illegal
- Collusion
- Manipulation

