ENERGY POLICY

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COMMODITY DERIVATIVES BASICS

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

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 to better by choosing a different hedge ratio (statistical methods)

COMMODITY DERIVATIVES CONTRACT DESIGN

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

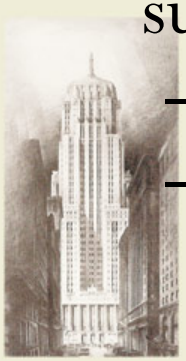
- Delivery-settled contracts *can* be used to transfer ownership, but that's not the main role of the delivery mechanism
- Delivery ties together cash and futures prices at expiration: "convergence"
- In this way, delivery ensures that futures prices reflect physical market realities at expiration: the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

TRADING MECHANISMS

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

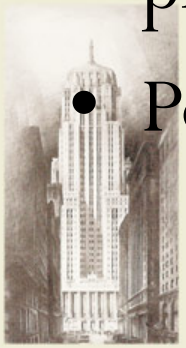
- Old School: floor trading in "pits"
- Some floors have closed (e.g., ICE), others a shadow of their former selves (e.g., NYMEX CL pit)
- Main floor activity today is in options
- Most trading is electronic: double sided electronic auctions

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

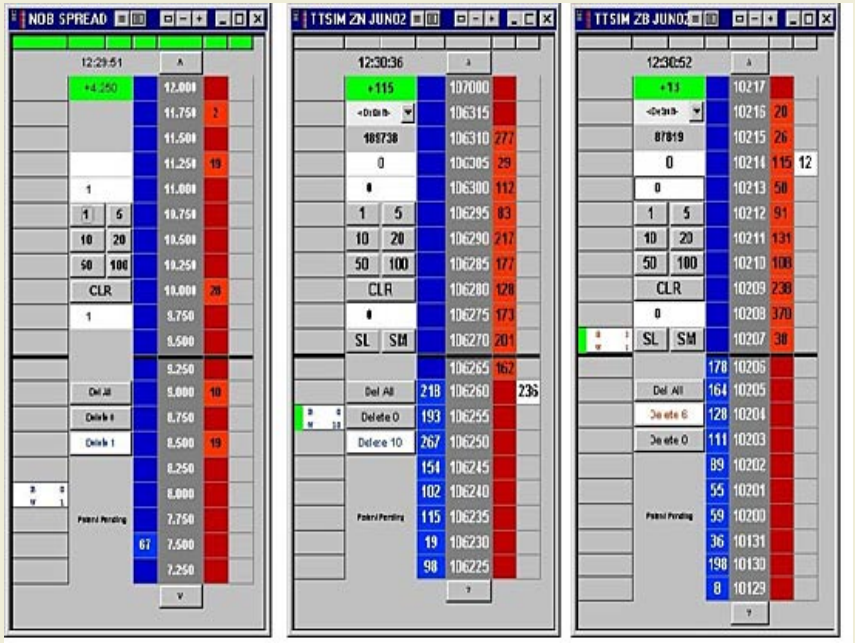
- Concentrate liquidity: some participants ("market makers" or "locals") specialize in supplying liquidity by actively quoting prices
- Considerable pre-trade transparency especially in computerized markets (in floor markets, those on the floor have advantages in observing current prices)
- Post-trade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



Pit Images

Old School Pit Images

New School Centralization



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)

EXCHANGES

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, soybeal 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 (once upon a time—not anymore!)

Major Exchanges: Industrials and Fibers

- CME: plywood
- ICE Futures: cotton

Major Exchanges: Softs

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

OTC TRADING

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

Swap Execution Facilities

- US has implemented a "SEF" mandate that requires certain swaps to be traded on centralized platforms
- Limit order book vs. RFQ
- RFQ requirements
- "Worst of Frankendodd": one part of Dodd-Frank that is likely to be changed
- Early implementation in the US (vs. Europe) has fragmented liquidity

COMMODITY TRADING

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

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)
- Export bans

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/locational 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

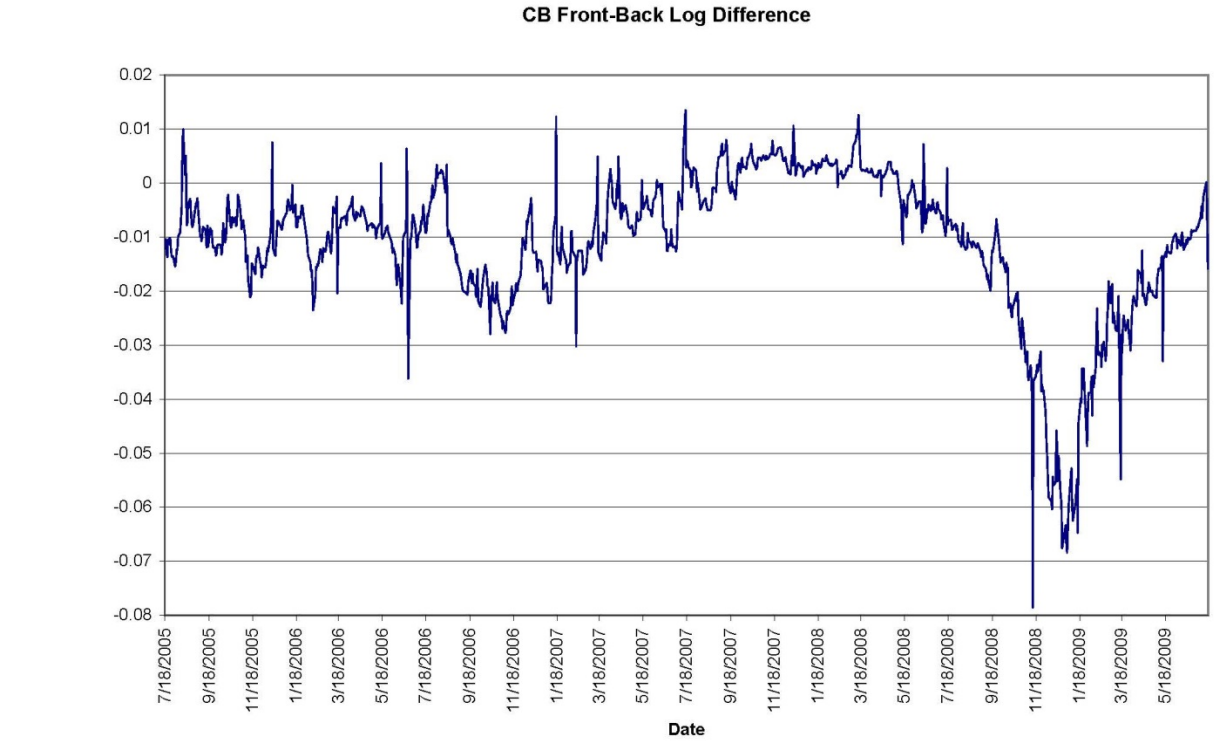
Light-Heavy Differential Example

- 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

Supercontango



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

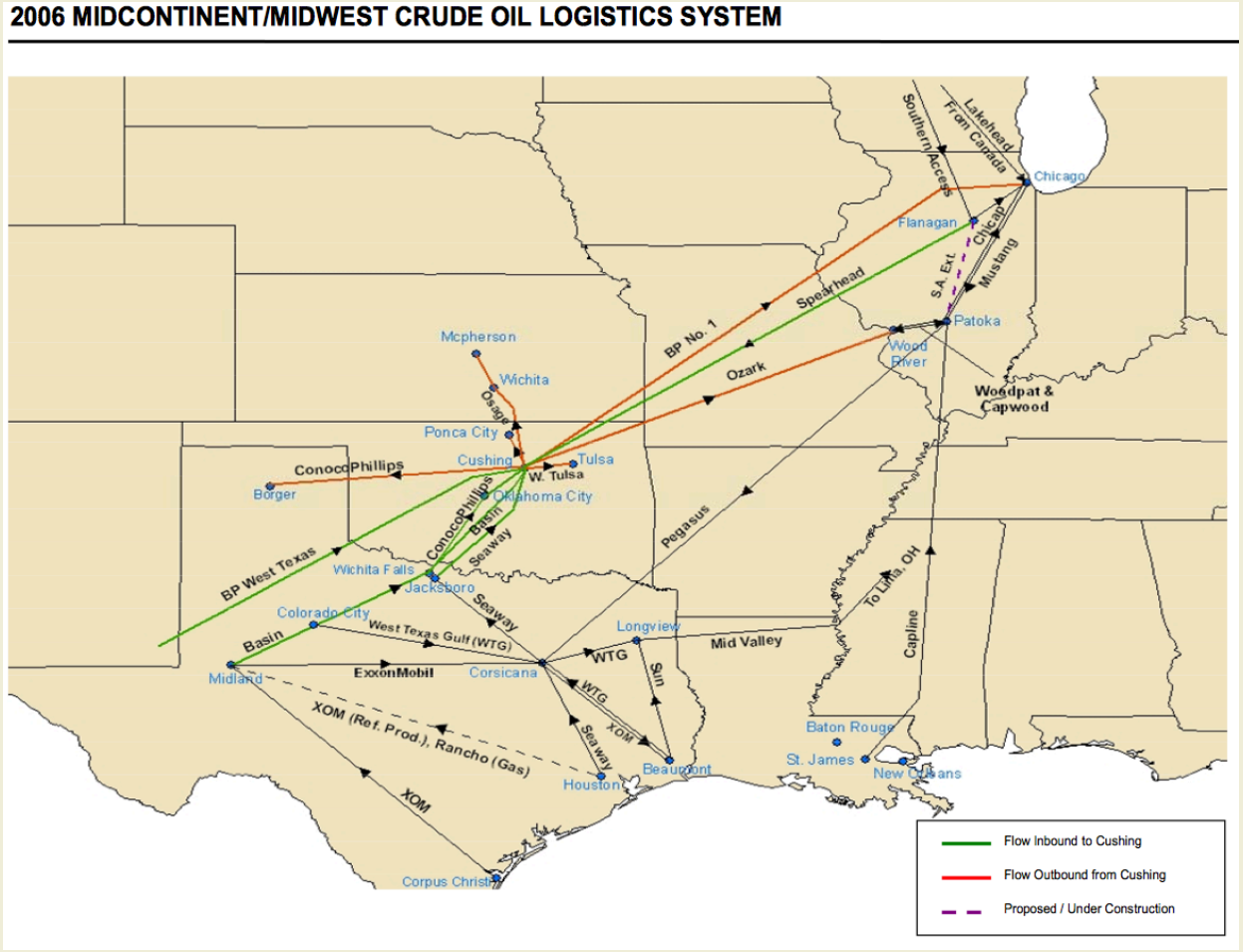
US Oil Markets: An Extended Example

- Major changes in North American oil markets in the past decades
- Major supply and demand shocks have affected pricing relationships
- Marginal barrel determines price: where the marginal barrel comes from depends on shifting supply and demand conditions
- Seasonal and secular shifts

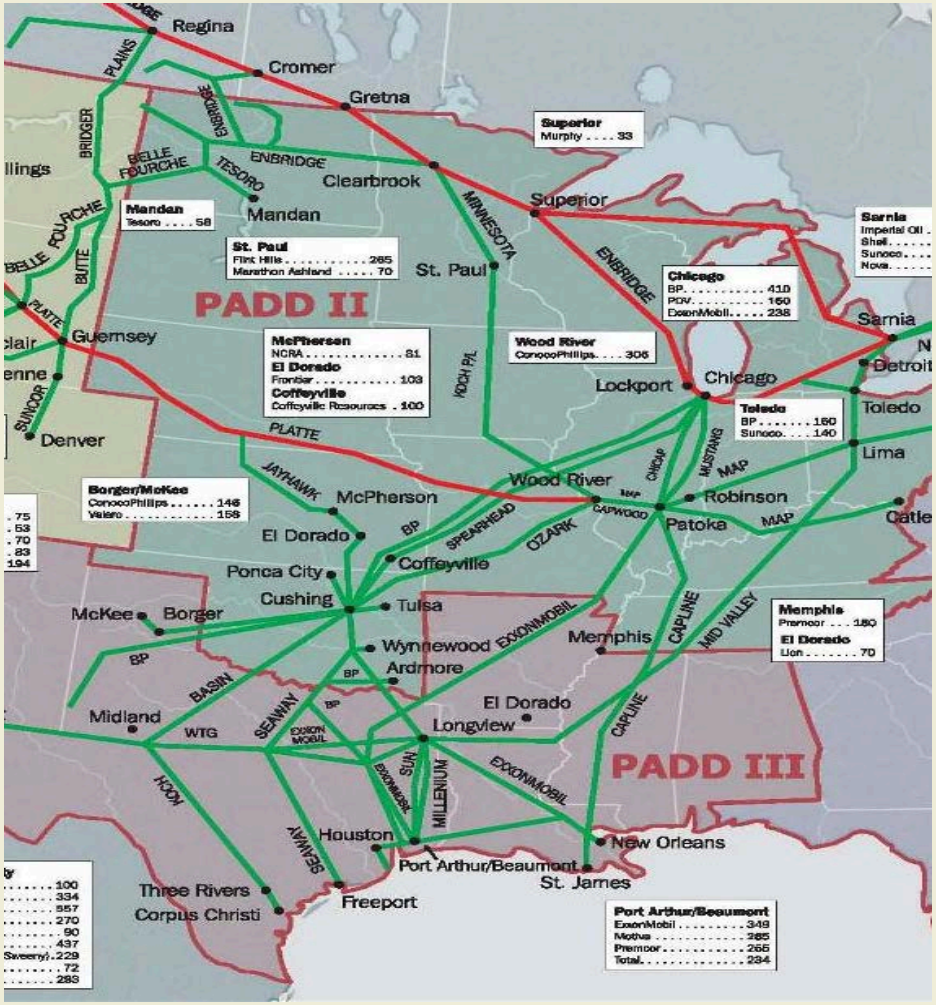
An Overview

- 1990s-early 2000s: US Midcontinent became a deficit supply region: marginal barrel was from imports. Oil flow mainly south-to-north. Midwest supplied from Canada
- 2008: Financial crisis led to a substantial decline in demand
- Post-2008: huge increases in output in Midcon, S. TX and W. TX.
- Complete shift in pricing relationships due to bottlenecks

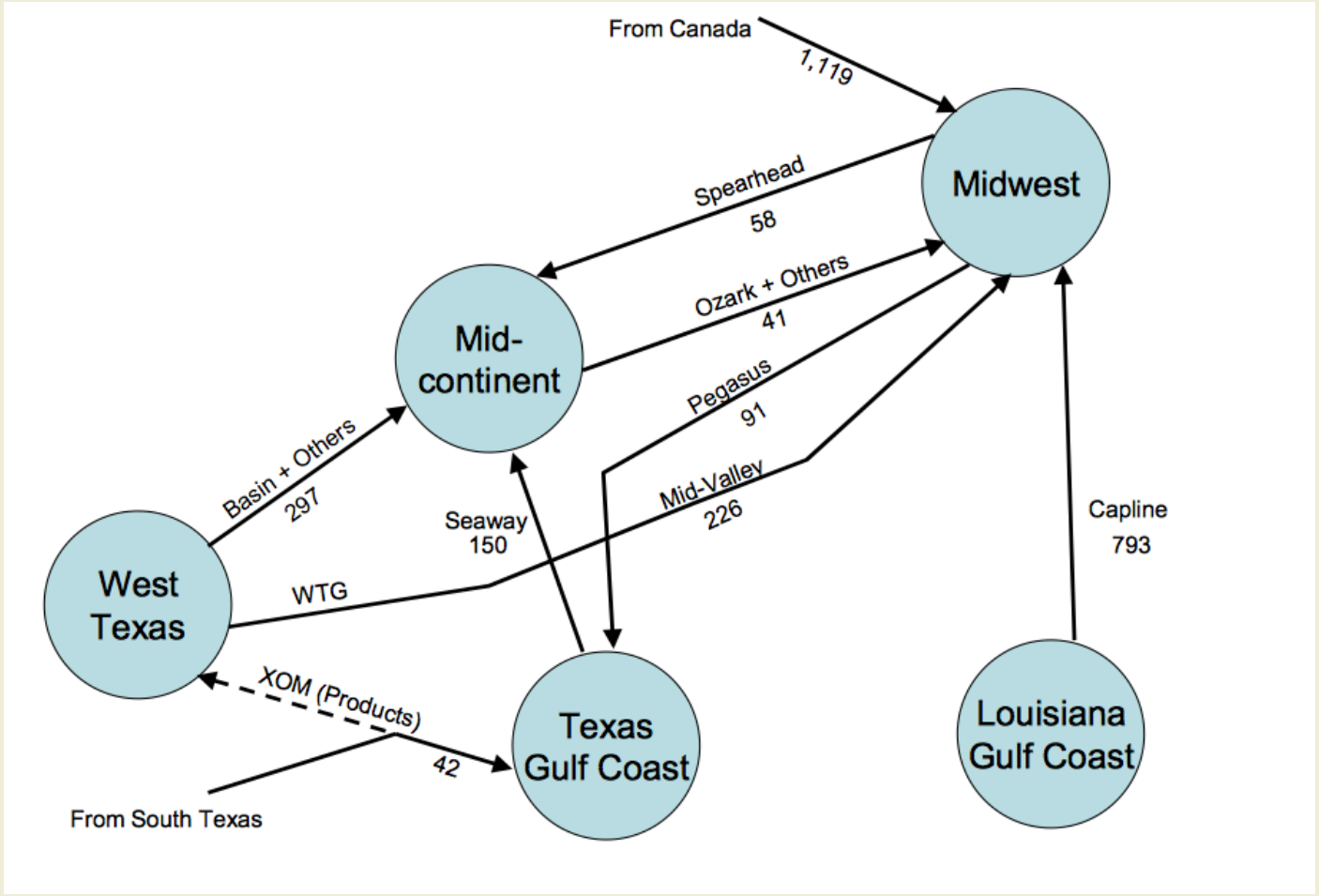
Midcon Infrastructure



Midcon Infrastructure II



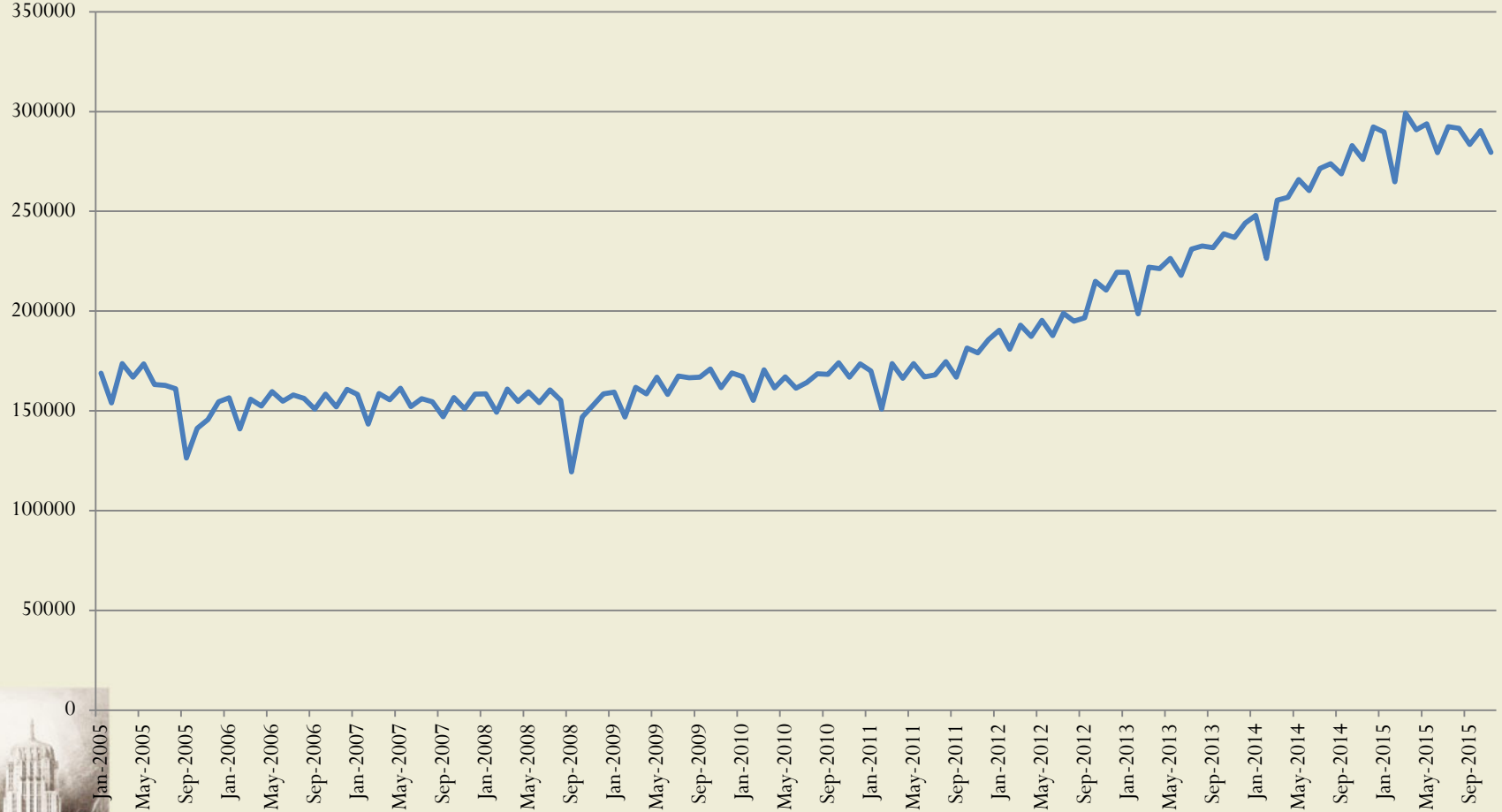
Midcon Flows



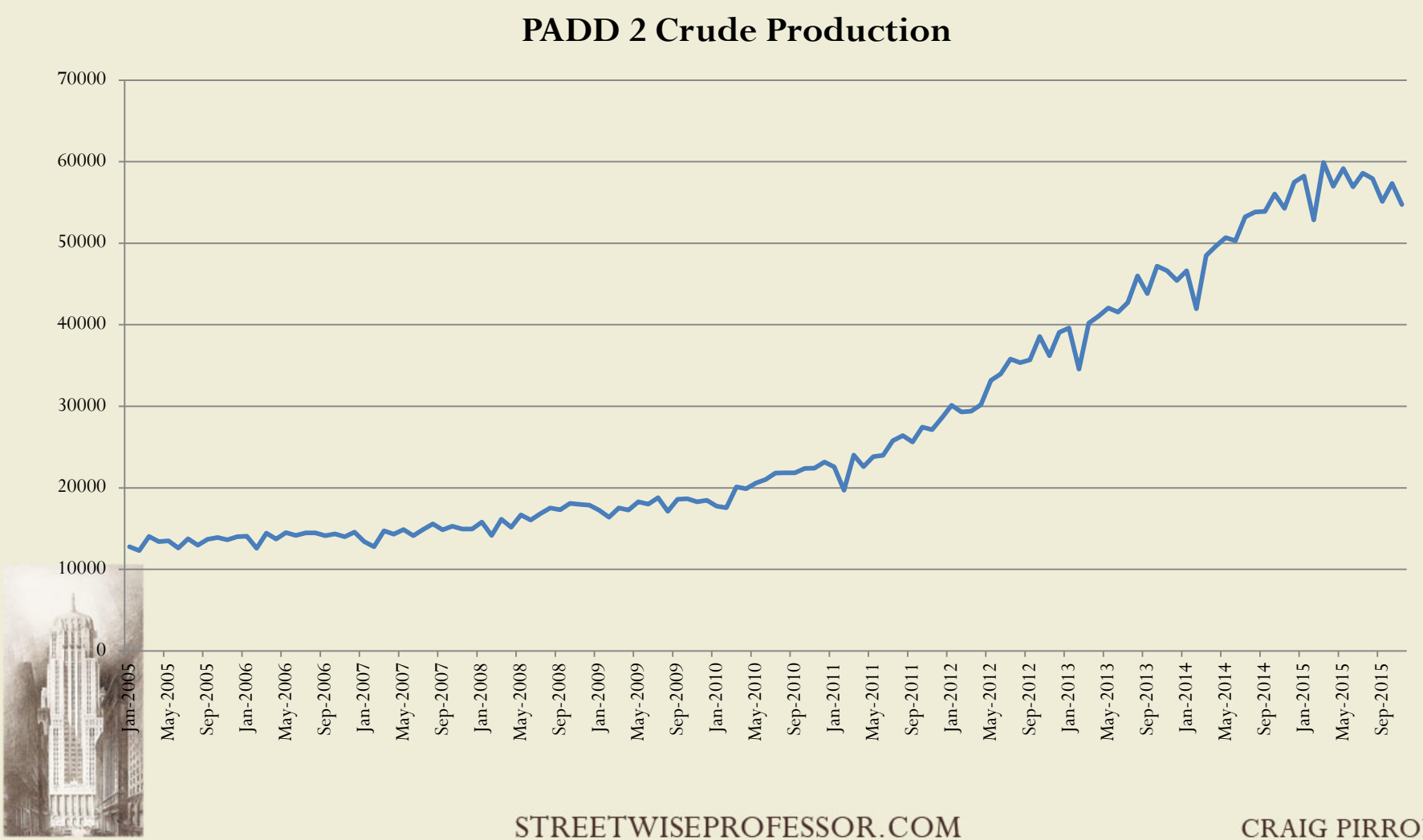
Cash Basis Relationships

- Midcon prices above prices at GOM by cost of transportation prior to shale boom
- Shale boom created huge bottlenecks: excess supply in Midcon and parts of TX, no way to get it to Gulf, and Midcon refineries operating at full capacity
- Pricing relationships flipped: Midcon at a huge discount to GOM until bottleneck alleviated by reversal of pipelines, addition of rail and barge capacity
- Now the bottlenecks is legal: GOM-Midcon=cost of transportation, but GOM at a discount to foreign crude due to export ban

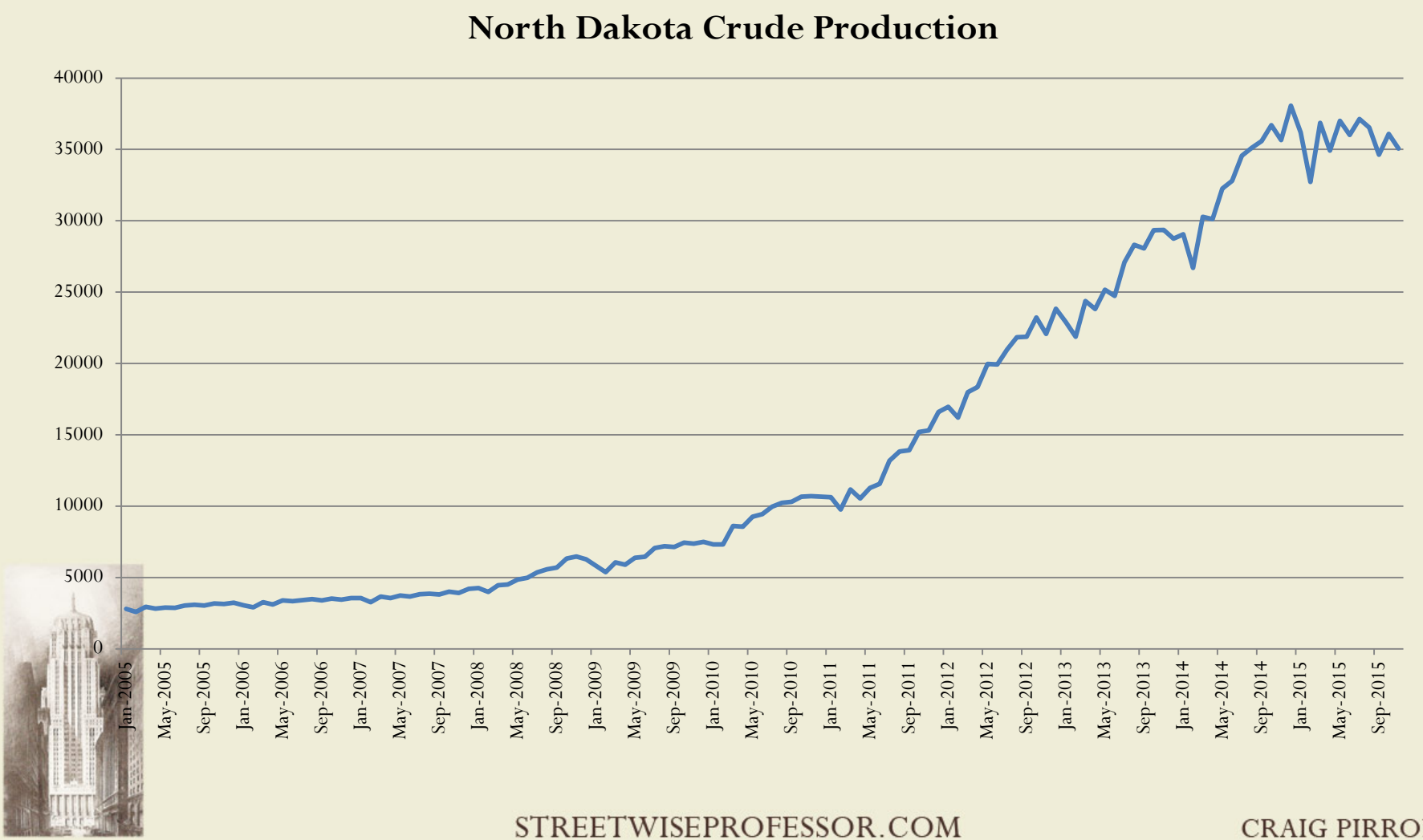
US Oil Output



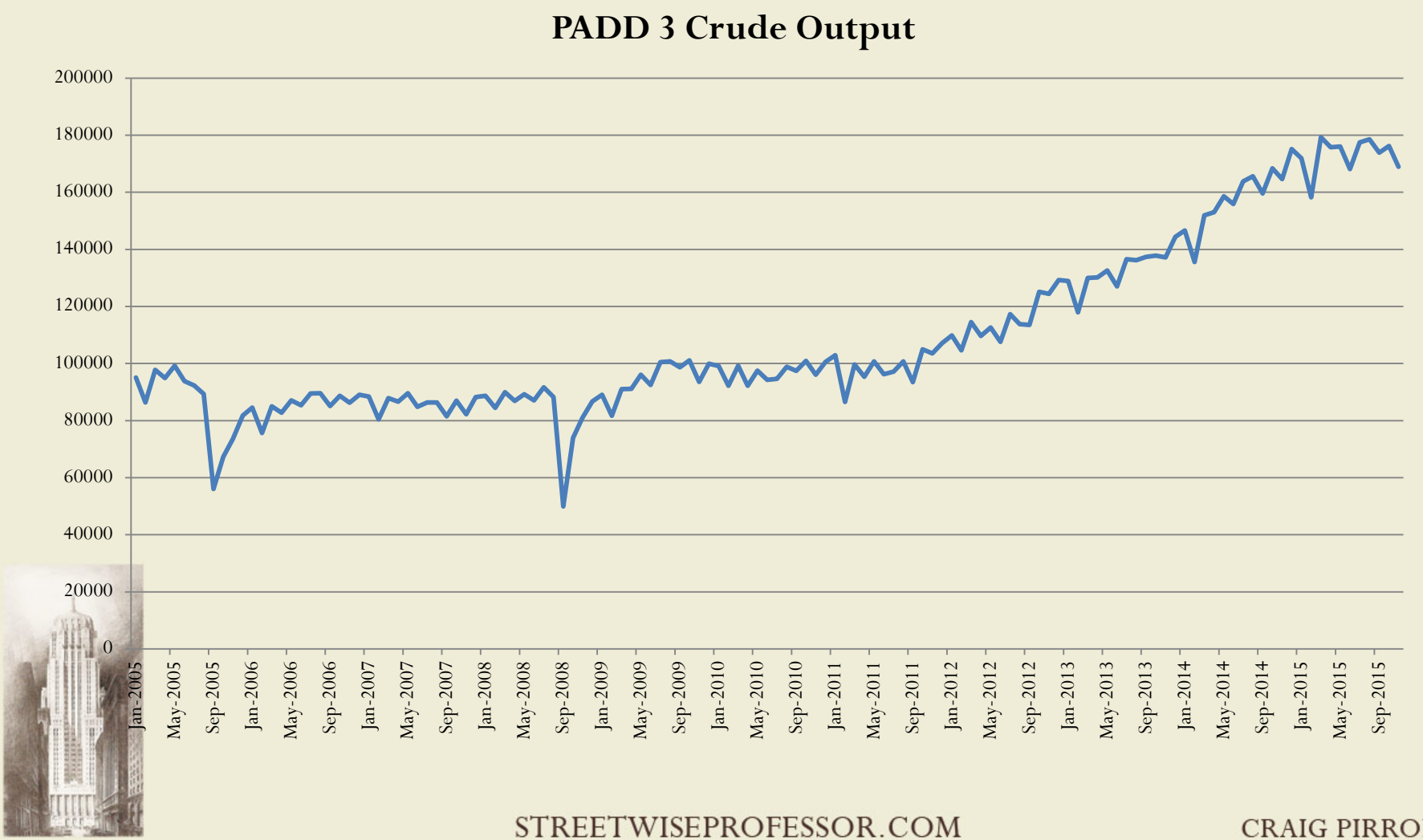
PADD 2 Output



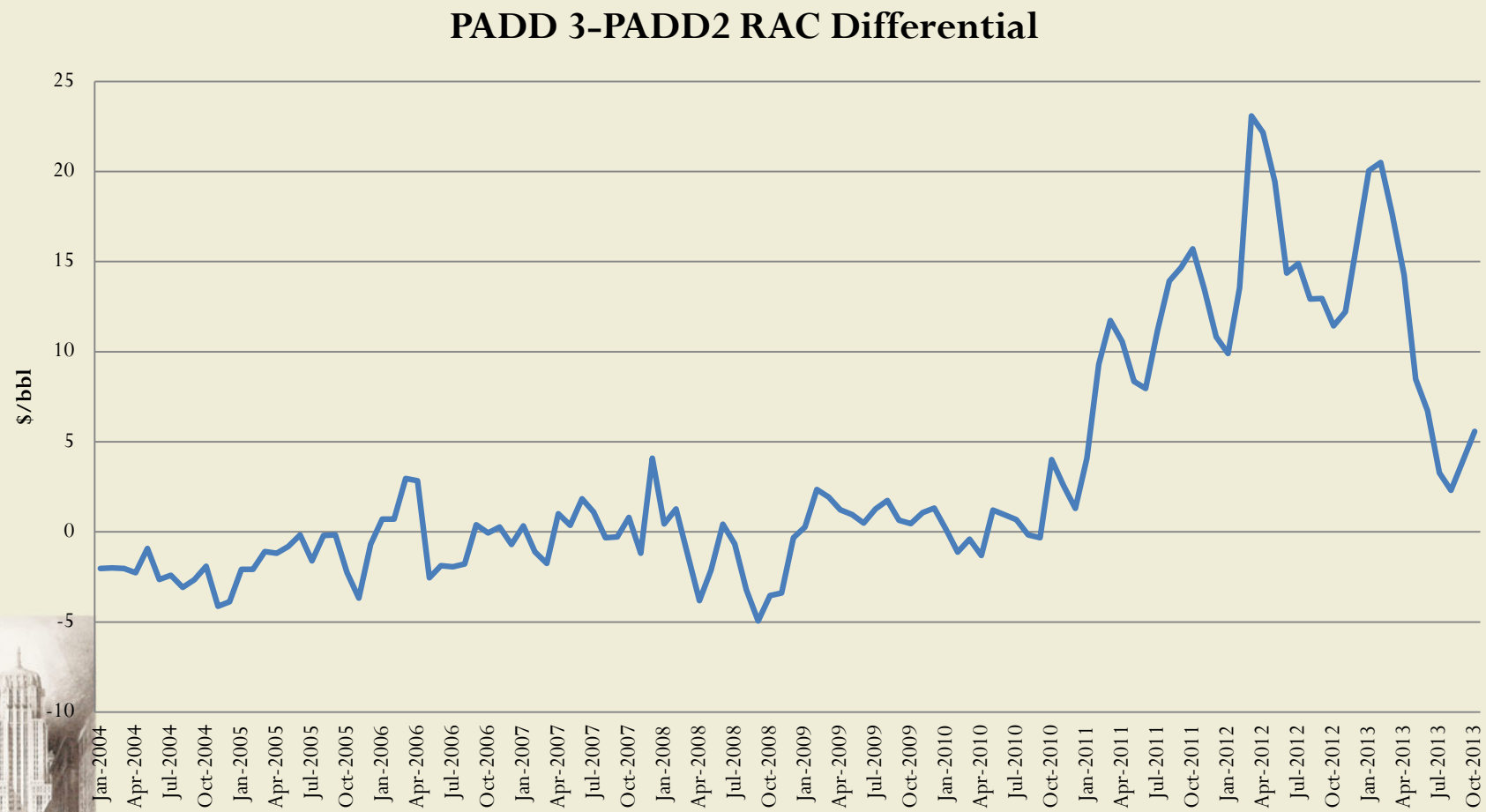
North Dakota Output



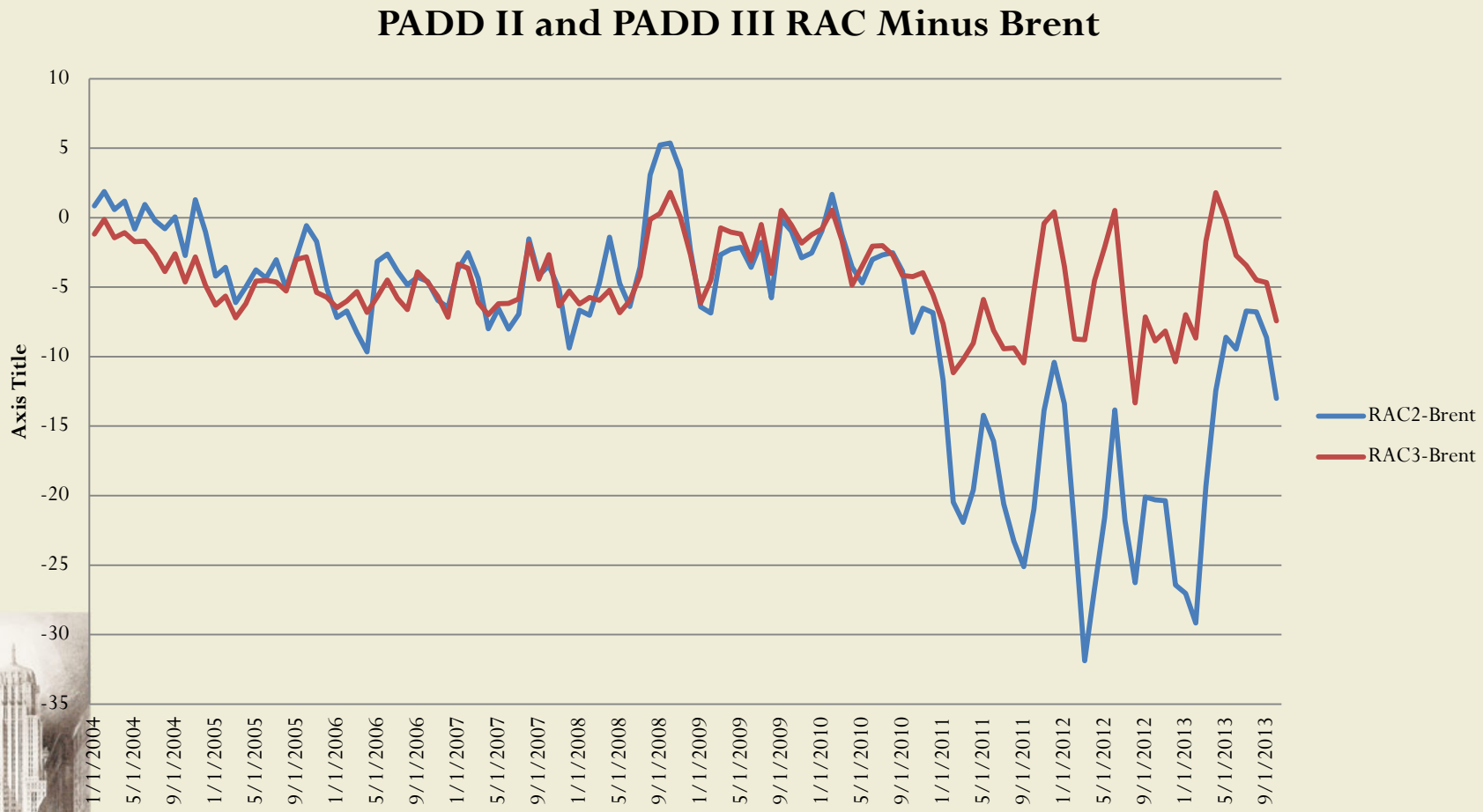
PADD 3 Output



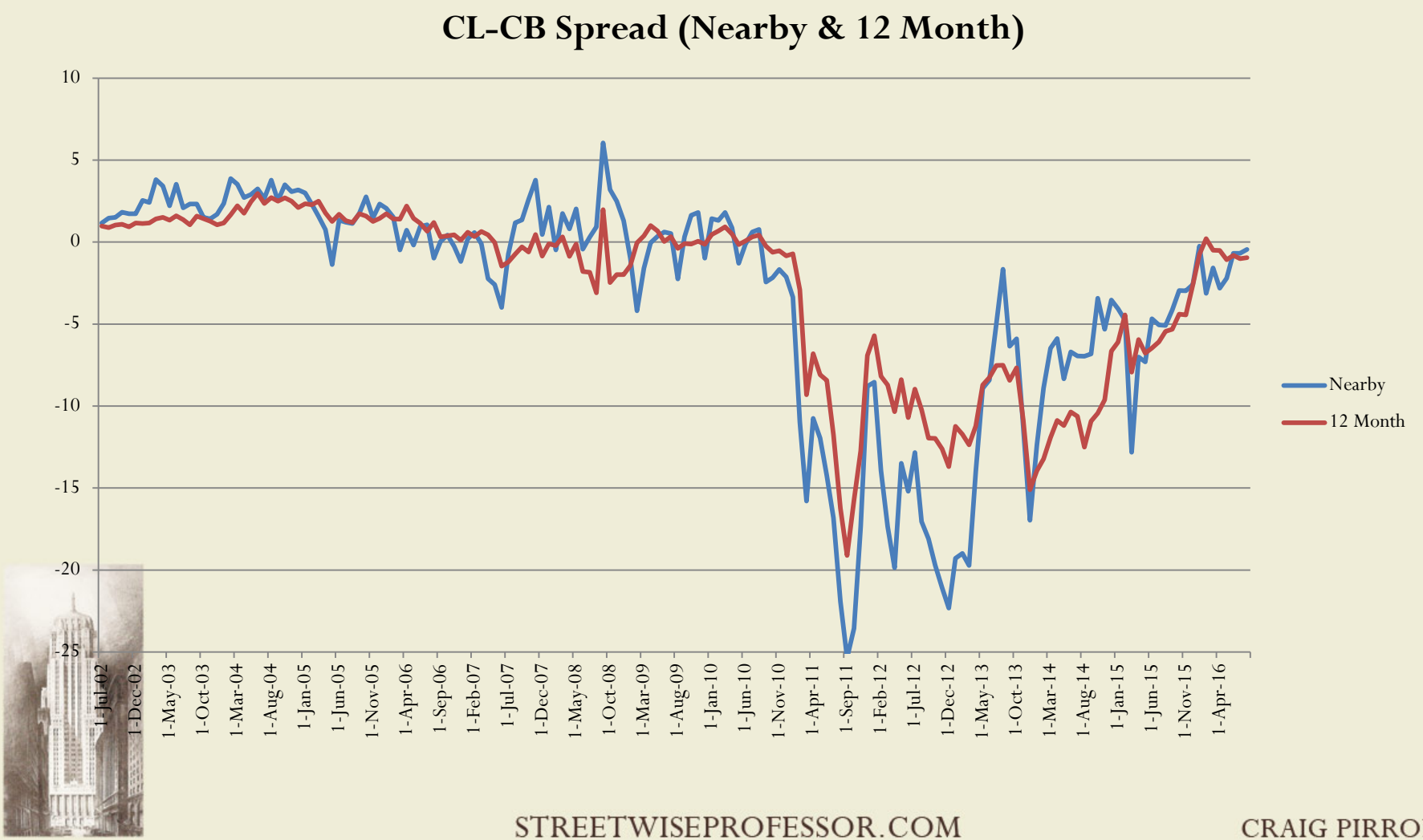
Crude Price Differential



US Prices vs. Brent



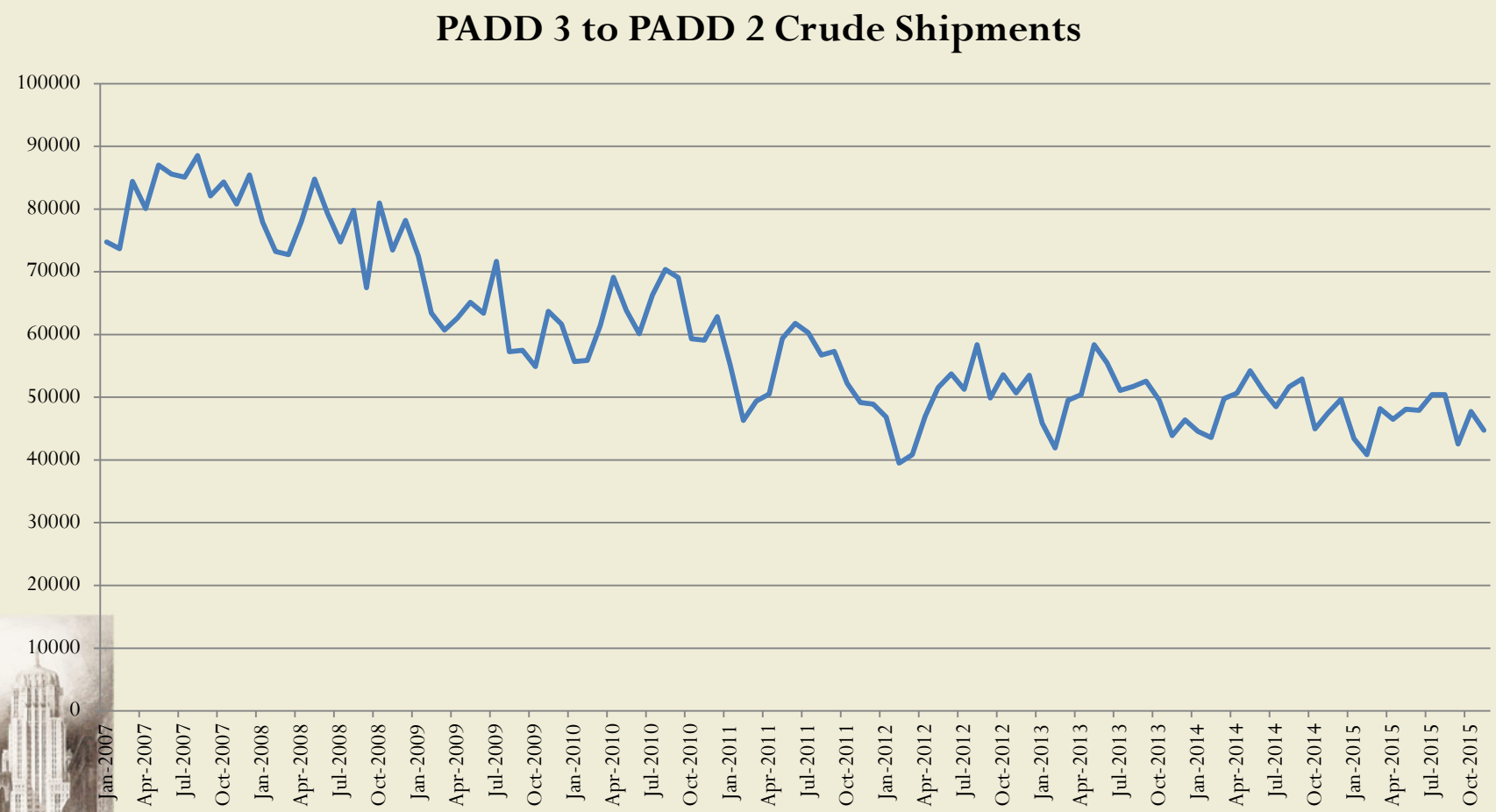
WTI-Brent Futures Spreads

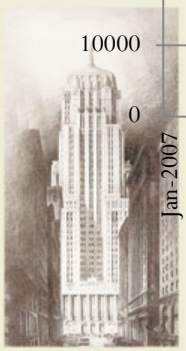


Commodity Flows & New Infrastructure

- Dramatic reversal in direction of oil flows
- Utilization of rail, barge and even truck to circumvent bottlenecks
- Displacement of imports, especially from Nigeria (shale oil light and sweet)
- Reversal of pipelines, construction of new pipelines
- Increased product exports to circumvent ban on crude exports, increased investment in refining capacity
- Building of "splitters" ("mini-refineries") to circumvent ban on crude exports

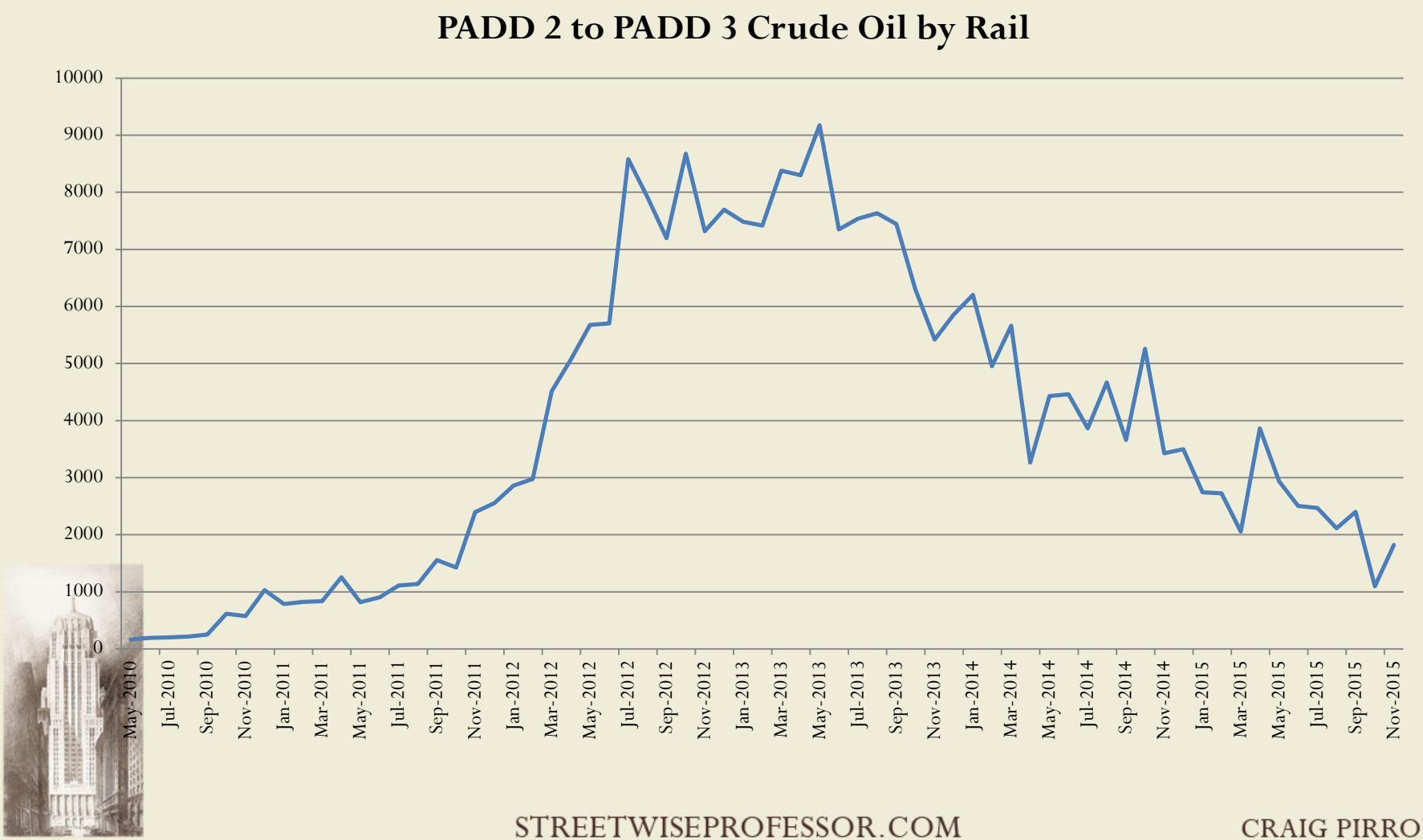
Crude Shipments





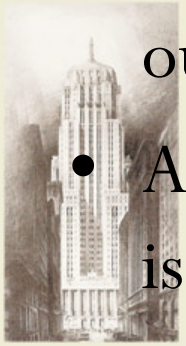
Crude Shipments

Rail Shipments

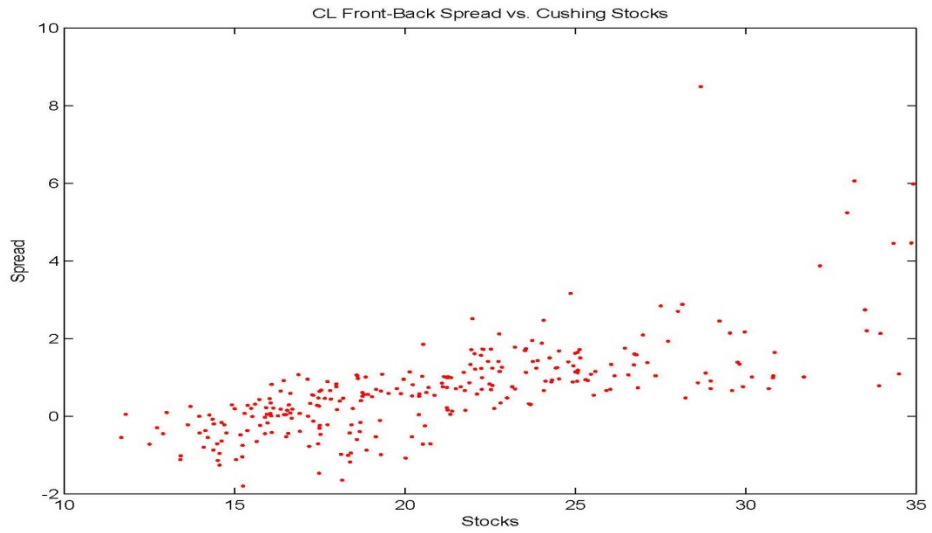


Time Spreads and the Crisis

- 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: Low demand plus inability to move oil out of Cushing to Gulf
- 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



CL Supply of Storage



Market Responses

- Substantial increase in storage capacity at Cushing
- Using VLCCs to store oil

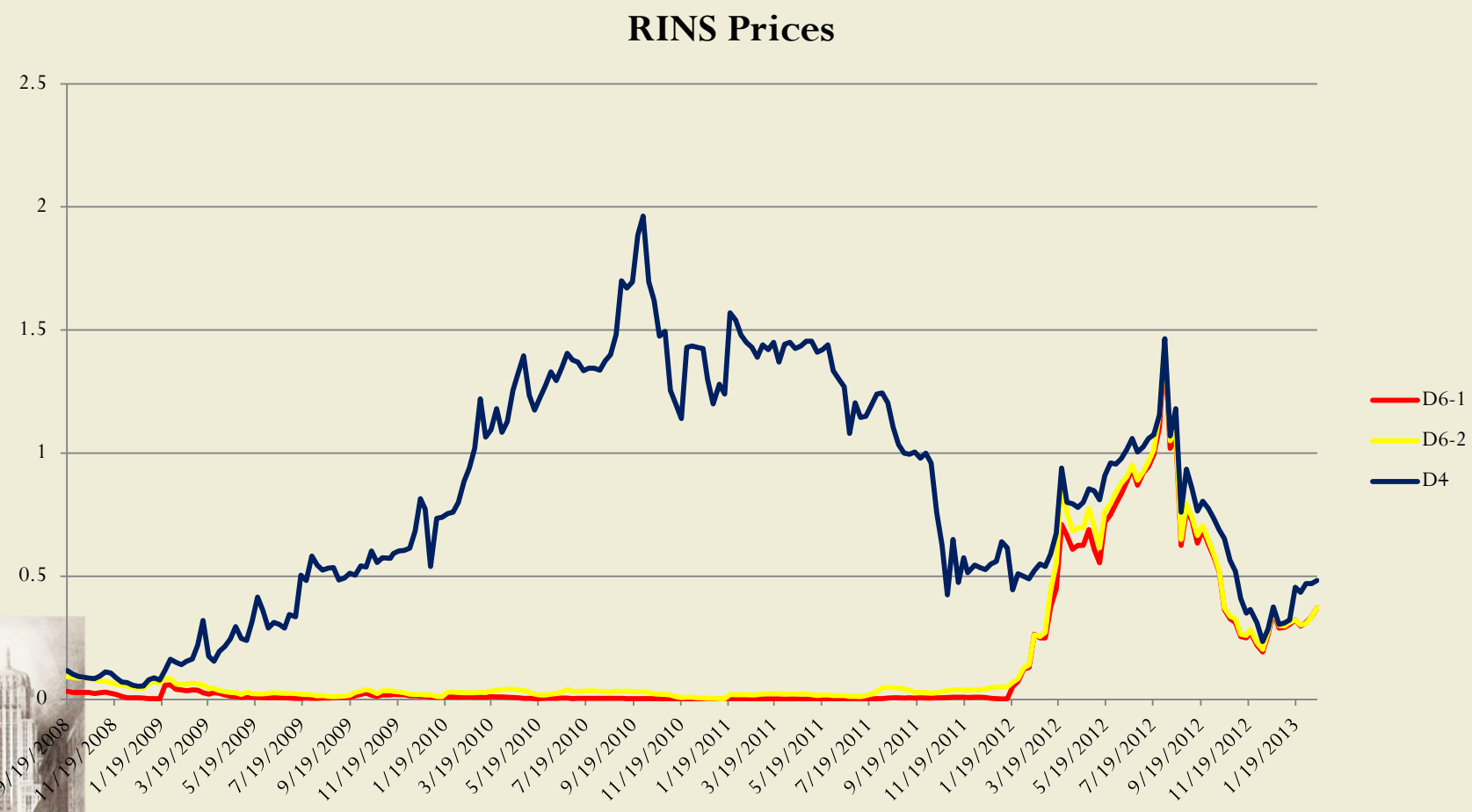
Grains in the US

- In 2006-2008, spreads between the grain futures prices (and the prices of shipping certificates) and cash grain prices in the country (e.g., elevator bids) reached historically high levels
- This differential should reflect the cost of transforming stored grain to grain on a barge
- What is the bottleneck?
- Huge inventory build (driven in part by impending renewable fuel mandates)
- Anything else?

RINs

- Renewable ID Numbers ("RINs") provide an example of how a regulatory bottleneck can affect pricing
- Congress mandated increasing use of biofuels (e.g., ethanol) but decline in gasoline usage and technical limitations on the amount of ethanol standard engines can use ("the blend wall") caused dramatic increase in the demand for unused certificates issued in prior years
- Huge price spike

Hitting the (Blend-) Wall



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"(California Power Crisis)

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

Aluminum

- Premiums between aluminum delivered to users and in-store (LME) prices increased dramatically in mid-2009
- Stocks of aluminum rose dramatically during the crisis
- Operator of the largest LME storage facility exploited LME rules, and engaged in "queue jamming" tactics to constrain loadouts of aluminum when demand started to rebound