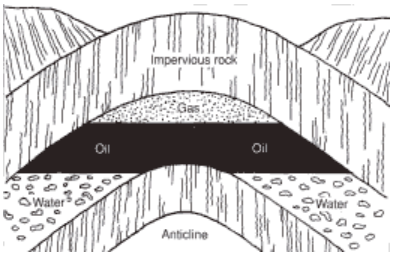
CRUDE OIL

Proven Reserves: 2003
(1 barrel = 159 litres)

Country	Crude Oil (billion barrels)	OPEC
Saudi Arabia.	261.8	yes
Iraq	112.5	yes
United Arab Emirates	97.8	yes
Kuwait	96.5	yes
Iran	89.7	yes
Venezuela	77.8	yes
Russia	60.0	
Libya	29.5	yes
Nigeria	24.0	yes
United States	22.7	
China	18.3	
Qatar	15.2	
Mexico	12.6	
Norway	10.3	
Algeria	9.2	yes
Kazakhstan	9.0	
Brazil	8.3	
Oman	5.5	
Angola	5.4	
India	5.4	
Canada	5.2	
Indonesia	5.0	yes
United Kingdom	4.7	
Ecuador	4.6	
Yemen	4.0	
All Others	43.2	
World Total	1,038.2	

But, Canada has 174.8 billion barrels of bitumen (in oil sands). If you count the bitumen, Canada is Number 2 in reserves.
OPEC accounts for 77% of conventional reserves (Saudi Arabia for 25%).

Oil Pool

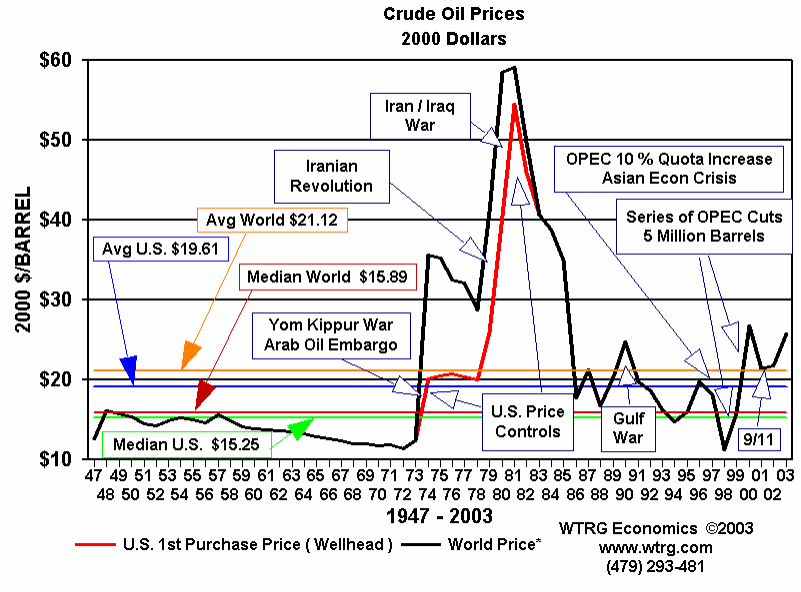


Extraction was encouraged in the U.S. by depletion allowances.

Normal Accounting:	
Well head price	$3.10
minus Operating cost	-1.35
equals actual Net Revenue	1.75
income tax (52%)	.91
Equals net revenue after tax	.84

Assume a depletion "allowance" of 27.5% of the well head price.
27.5% of $3.10 = $0.8525 This is treated as a cost! It is deducted from net revenues. Result: Pump America dry.

Depletion Accounting	
Well head price	$3.1000
minus Operating cost	-1.3500
equals actual Net Revenue	1.7500
minus .depletion allowance	-.8525
equals taxable Net Revenue	.8975
income tax (52% of .8975)	.4667
Actual Net Revenue	1.7500
minus income tax	-.4667
Equals net revenue after tax	1.2833



The OPEC Rationale

1. The Competitive Model

$$P_0 - MC \quad \text{vs.} \quad \frac{P_0(1+g) - MC}{1+r}$$

Where P_0 = price of oil today
MC = cost of production
g = expected increase in price of oil
r = the real rate of interest

Assume MC = 0 (which is close to the truth once the well is dug),
Then if g > r, oil producing country will leave the oil in the ground.

Does this explain the price hikes in 1972 and 1979?

2. Property Rights Model

3. Target Revenue (Figures 3.6 & 3.7)

4. Cartel Theories (Figure 3.8)

5. The Crutch Theory (Figure 3.9)

The Response of Consuming Countries

UNITED STATES

1. Price Controls (Figures 3.10 & 3.11)

2. Taxation

CANADIAN OIL POLICY

Fact, oil is found in Alberta and to a much lesser extent in Saskatchewan and British Columbia. Most oil is consumed in the two most populated provinces, Ontario and Quebec.

I. Pre-OPEC (1959-1973)

1. Supply all areas west of Quebec with Alberta oil
2. Supply Quebec and the Maritimes with imported oil (mainly from Venezuela)
3. Ship as much oil to the U.S. as they would allow in.
4. Let world prices (which were low) prevail.

II. Post-OPEC (1974-1980)

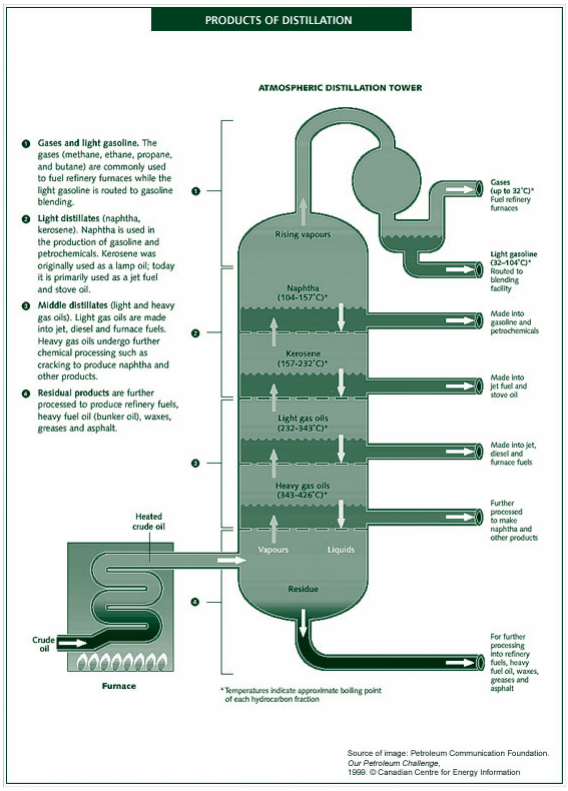
1. Maintain Canadian prices below world prices.
   a) 1974, world price = $11; Canadian price = $6; federal government placed a $5 tax on oil exported to the US, used the money to subsidize purchase of foreign crude for Quebec and Maritimes refineries.
   b) By 1979, differential was about $3; then OPEC doubled prices again.
2. Friction between Alberta and the federal government over who would get the rents.

III. The National Energy Program (NEP), 1980-87

1. World price goes to CAD 40/barrel in 1980, domestic price about $20.
2. Federal government receives about 10% of the gross income from Canadian oil -- cannot afford to continue to subsidize purchases of foreign crude.
3. Federal government increases its share with NEP; Alberta government orders production cut back.
4. Under NEP Petro-Canada (a Crown corporation) is created to provide a window on the industry.
5. Eventually world prices decline, the NEP is abandoned.
6. Petro-Canada is privatized.

REFINING AND MARKETING

High degree of vertical integration in the petroleum sector (oil reserves, refining, transportation, retail marketing).



Some theory:
VERTICAL INTEGRATION

A Definition: Combination of technically separable production steps in one enterprise.
Puzzle: Why does this happen? Why internalize as opposed to using the market? The so-called "make or buy" decision.

B Rationales

1 Market failure (i.e., why don't markets exist between the transactions?)

a Conditions:

i degrees of uncertainty

ii frequency of transaction

iii degree of asset specificity

(i) site specificity

(ii) dedicated assets

(iii) human asset specificity

iv Danger: quasi rent capture

v Solution: vertical integration

b Co-ordination Economies

i Resource flows

ii R&D

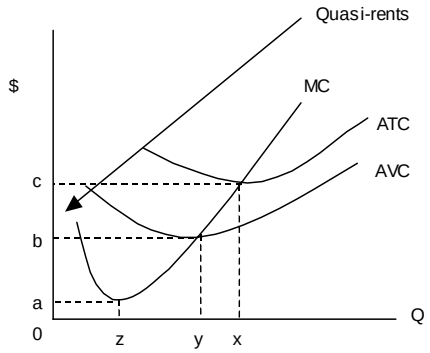
c Pursuit of market power

i Extension of market power

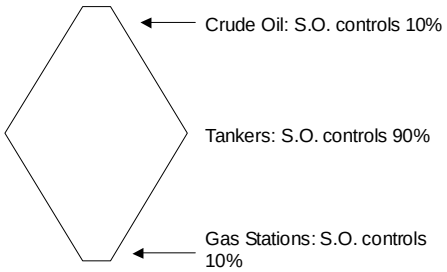
ii Creation of entry barriers

(i) pre-emption of scarce resources

(ii) increase entrants' capital costs



Double Taper Price Squeeze



ECONOMIES OF SCALE IN REFINING & TRANSPORTATION

Significant Economies of Scale (Figures 4.2, 4.3, 4.4)

- Plant level scale economies
- Firm level scale economies
- Unit transportation costs

Plant level

Engineering reality: the two-thirds rule

Cylinders
A = area
V = volume
r = radius
pi = pi

$$A = 4\pi r^2$$

$$V = \frac{4}{3}\pi r^3$$

Capital cost is a direct function of area.
Capacity is a direct function of volume.
For a given increase in "r" volume goes up faster than area.
If capacity is increased by "X", then capital costs increase by "$X^{2/3}$
Implication: scale economies in refineries and pipelines.

Firm level
Unit transportation costs

Concentration Levels in Refining

			('000 m3/d)
Imperial	Edmonton	Alberta	29.0
Petro-Canada	Edmonton	Alberta	19.9
Shell Canada	Edmonton	Alberta	18.2
Husky	Prince George	BC	1.6
Chevron	Vancouver	BC	8.3
Irving	Saint John	NB	39.7
North Atlantic Refining	Come-by-Chance	Nfld	16.7
Imperial	Dartmouth	NS	13.0
Imperial	Nanticoke	Ontario	17.8
Petro-Canada	Oakville	Ontario	13.2
Imperial	Sarnia	Ontario	19.2
Shell Canada	Sarnia	Ontario	11.4
Suncor	Sarnia	Ontario	11.1
Petro-Canada	Montreal	Quebec	16.7
Shell Canada	Montreal	Quebec	19.4
Ultramar (Valero)	St. Romuald	Quebec	34.0
Consumers' Coop	Regina	Sask.	10.1

CONCENTRATION MEASURES:

1 Concentration ratios (CR4, CR8)
2 Herfindahl Hirschman Index (HHI)

$H = \sum_{i=1}^{n} P_i^2$ where Pi is the market share of the i^{th} firm

a In the US they use the percent market share as a whole number (e.g., 10% = 10). In Canada we use market share as a fraction (e.g., 10% = 0.1)
US monopoly: 100 x 100 = 10,000 = maximum HHI
Cdn monopoly: 1 x 1 = 1 = maximum HHI

b HHI declines
i the greater the number of firms
ii the more equal is market share

c HHI is "numbers equivalent"

when all firms have the same market share, $H = \left(\frac{1}{n}\right)$ because:

Refiner	('000 m3/d)	Share
Imperial	79.0	26%
Petro-Canada	49.8	17%
Shell Canada	49.0	16%
Irving	39.7	13%
Ultramar (Valero)	34.0	11%
North Atlantic Refining	16.7	6%
Suncor	11.1	4%
Consumers' Coop	10.1	3%
Chevron	8.3	3%
Husky	1.6	1%

CR4=73%
HHI=.1611

$$P_i = \left(\frac{1}{n}\right); \quad H = \sum_{i=1}^{n} P_i^2 = \sum_{i=1}^{n} \left(\frac{1}{n}\right)^2 =$$

$$\left(\frac{1}{n_1}\right)^2 + \ldots\ldots + \left(\frac{1}{n_n}\right)^2 = \quad n\left(\frac{1}{n}\right)^2 = \left(\frac{n}{n^2}\right) = \left(\frac{1}{n}\right)$$

Canadian Refining:

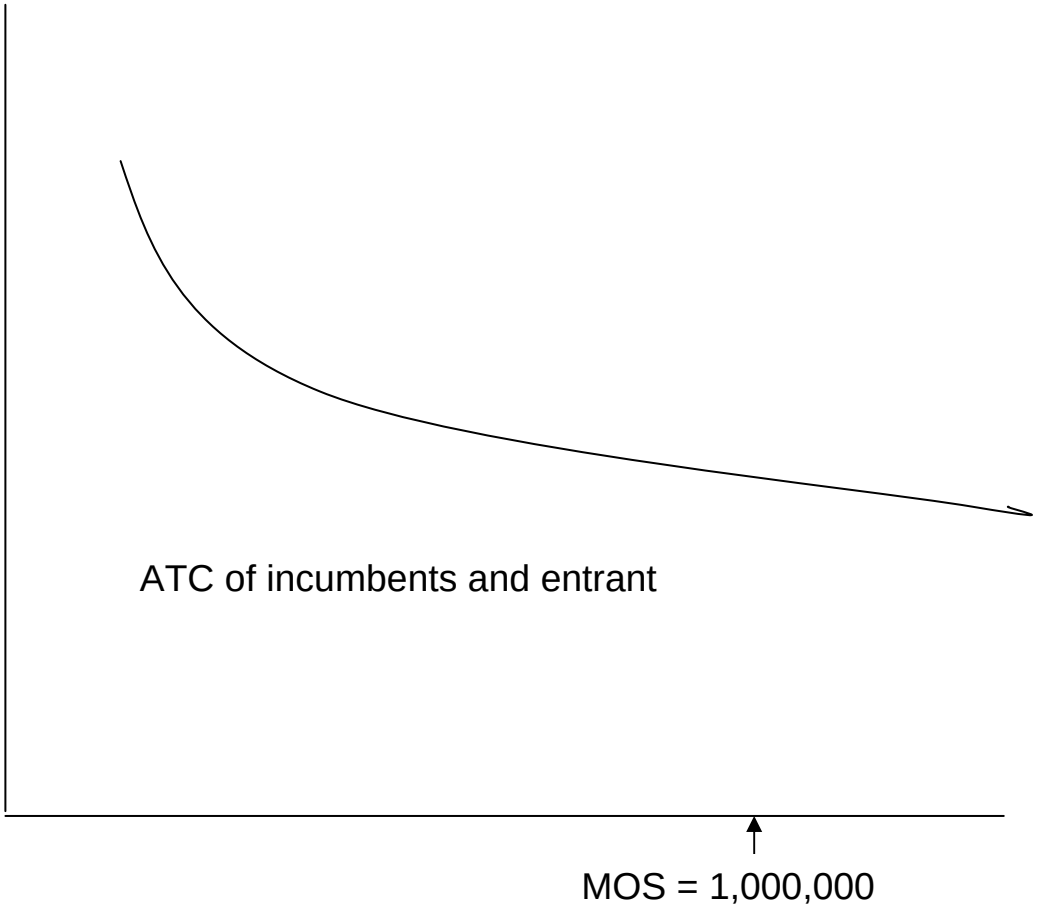
HHI= .1611
If all firms were the same size, HHI=1/n = 1/10 = .1000

But these calculations are flawed:

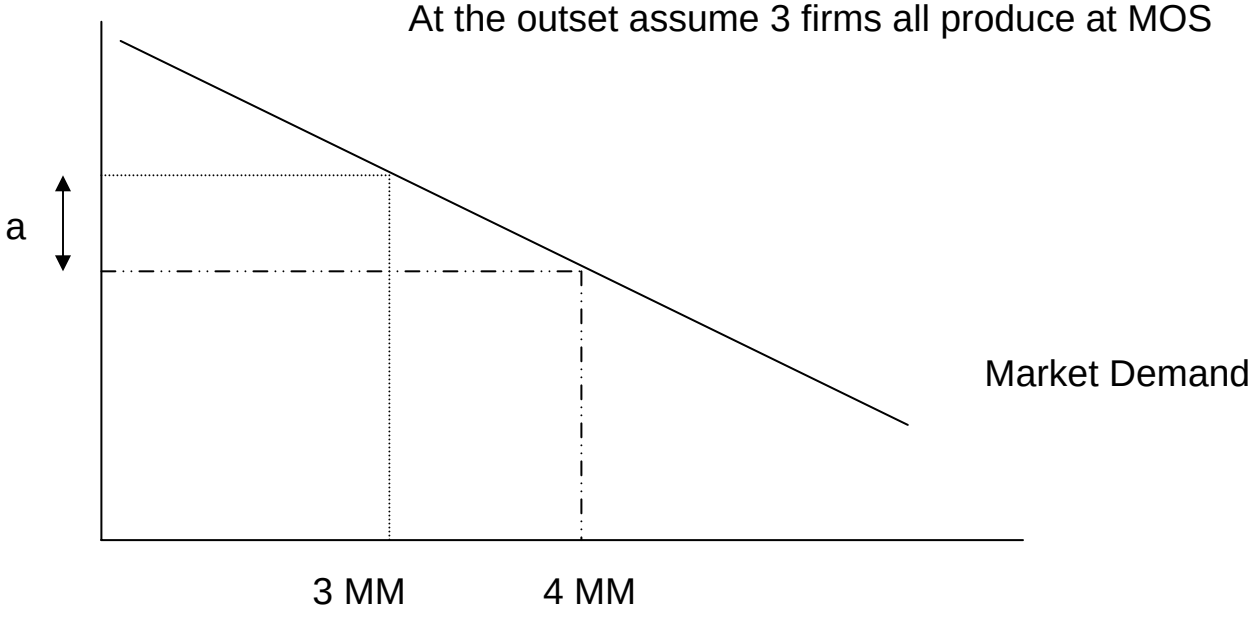
1 Markets are regional due to transportation costs.
2 Markets are not domestic (U.S. border refineries are in the relevant market).

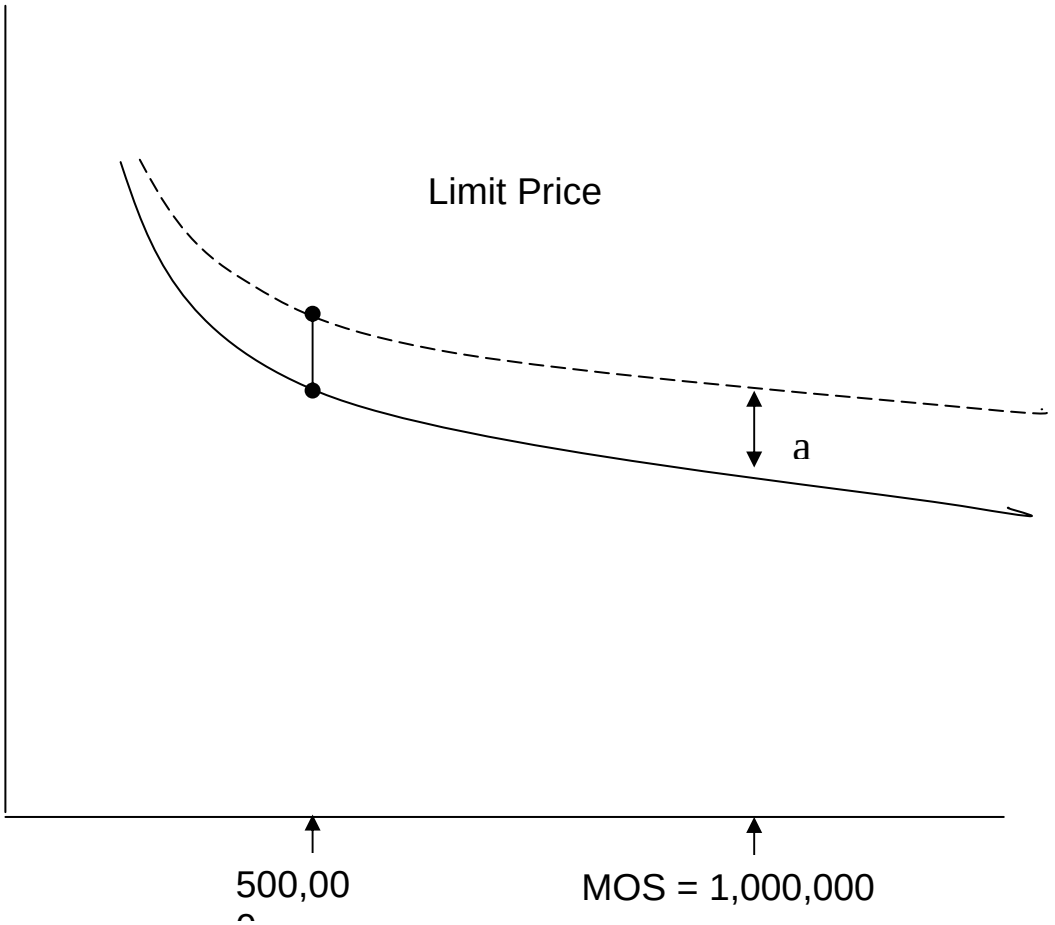
Entry barriers:
1 Necessary condition: high sunk costs to refining
2 Regulatory and environmental permitting (an absolute cost advantage)
3 Scale Barrier
4 Product swaps and the need to enter at multiple stages (adds to sunk costs)

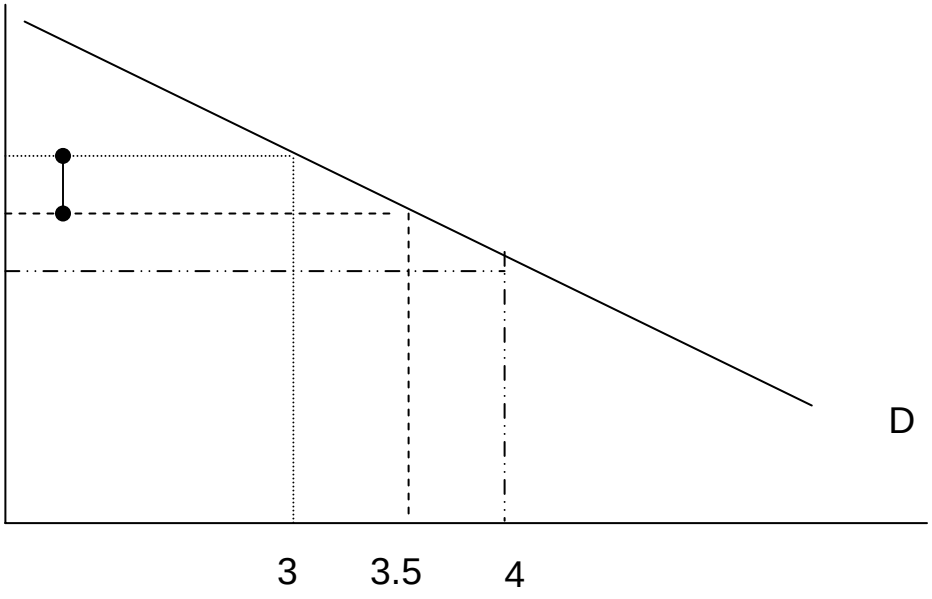
The Scale Barrier



At the outset assume 3 firms all produce at MOS




Limit Price
a
500,00
MOS = 1,000,000


D
3
3.5
4

Structure of Gasoline Retailing

Refiner/Retail Distribution relationships

	Company owned & operated	Commission retailer	Lessee	Indep. branded retailer	Indep. non-branded retailer
Who owns the station?	refiner	refiner	refiner	3rd party or retailer	3rd party or retailer
Whom does the retailer work for?	refiner	self	self	self	self
Who hires staff	refiner	retailer	retailer	retailer	retailer
Whose products are sold?	refiner's	refiner's	refiner's	refiner's	anyone's
How is retailer paid?	salary	commission per litre	station margin	station margin	station margin
Who sets prices?	refiner	refiner	retailer	retailer	retailer

Most stations are "branded" - this is a form of vertical integration, or quasi vertical integration

Rationales:
- efficiency
- foreclosure

Structure of gasoline retailing has changed dramatically from many, small volume stations to fewer, higher volume stations. Due to:
- Automobile technology (frequency of tune-ups and repairs dramatically reduced by improvements in auto technology and inputs -- e.g., quality of oil and tires)
- Consumers became more price sensitive
- Labour costs increased
- Zoning became more restrictive.

Efforts to stall the inevitable process
- prohibit self-serve
- forbid company owned stations
- allow franchisees to sell any refiner's gasoline

Pricing:
Chain Oligopoly

The Prisoners' Dilemma

Escape from the Dilemma
- Price fixing
- Price leadership
    - dominant firm leadership
    - collusive leadership
    - barometric leadership
- Signaling ("tit-for-tat" pricing strategies)

Are retail prices competitive?

a What is the relationship between Canadian wholesale prices and crude oil prices? (positively correlated)
b What is the relationship between Canadian wholesale prices and American wholesale prices? (positively correlated)
c What is the relationship between retail prices and wholesale prices? (positively correlated)
d Do retail prices change asymmetrically with wholesale price increases or decreases? (No)