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Abstract

An examination of major forces in the petroleum market with primary emphasis on the decade of the 1970s. The market force(s) responsible for the factor-of-ten increase in the price of crude oil is isolated, if not identified. The market's "message" is set forth for energy policy planners.

1. INTRODUCTION

The world petroleum market experienced generally unanticipated price discontinuities in 1973 and again in 1979. (Fig. 1) If the market was, and is, rational, it should be possible to identify the cause(s) of these price discontinuities as something other than fear or speculative greed. If the market is rational, any attempt to force the sale of oil at levels substantially removed from the market-clearing price will unnecessarily punish the economy and the citizens of the country in which prices are so regulated.

2. MARKET DEFINITION

As used here, "the market" is the weighted sum of the collective judgement of all participants to the commercial traffic in a given commodity at any given moment. We impute wisdom or prescience to the market even knowing that many participants are motivated by nothing more than the hope of making an extra quick buck. Stability of inertia of the market is enhanced by major long-range committments. In the competitive market economic error is generally borne by the author of the error, whether personal or corporate. By contrast, bureaucratic market makers rarely admit and, therefore, rarely correct their errors. The cost of bureaucratic market error is "passed through" to the taxpayer or consumer.

3. MARKET FORCES

Major market forces in commodities, whether grain, mineral or livestock, are recognizable without elaborate definition or scholarly background in economics. These forces are listed here with no signficance to their order:

(1) Marginal cost of production
(2) Fully allocated cost of production
(3) Cost of an available substitute
(4) Probable cost of an anticipated substitute
(5) An anticipated production-comsumption imbalance
(6) An actual production-consumption imbalance
(7) The cost of doing without.

This list is not inclusive. Moreover there are unlisted subsets. Nevertheless, an examination of the market forces listed here is adequate to reveal significant insight regarding the dramatic price changes in crude oil in the 1970s. Rather than attempt precision definition of these forces, we cite homely examples which convey meaning sufficient for the purpose of this paper.

(1) Marginal cost of production. The incremental or extra cost associated with producing one extra unit of a commodity in question. The marginal cost of producing an extra bushel of corn, for example, may be the cost of purchase and application of an extra 3 pounds of nitrogen fertilizer.[1]

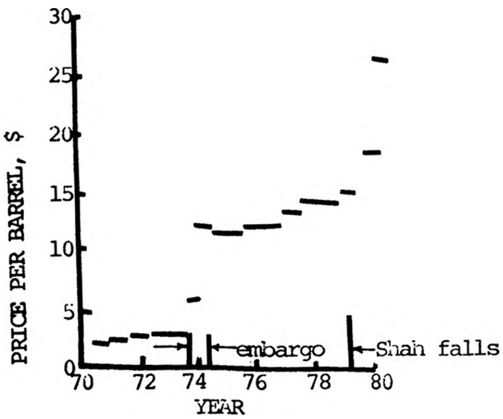

Fig. 1 Price of Arab Light crude

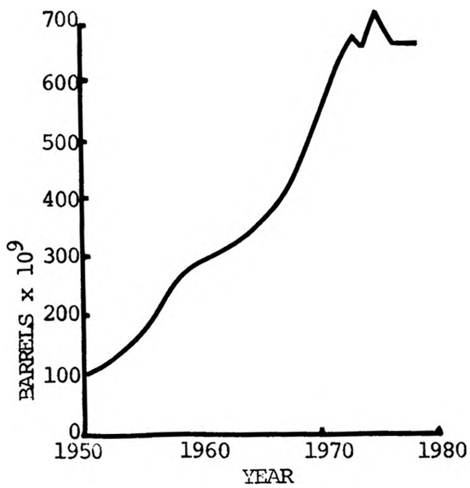

Fig. 2 World oil reserves

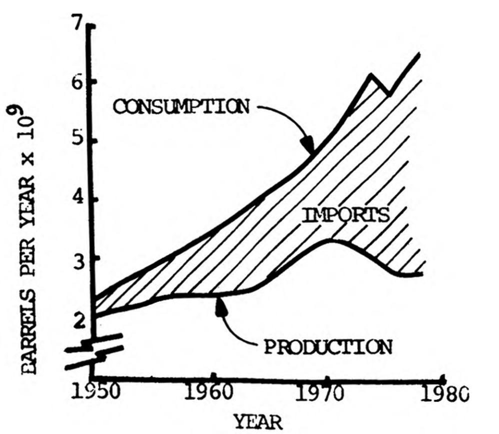

Fig. 3 U.S. oil production-consumption

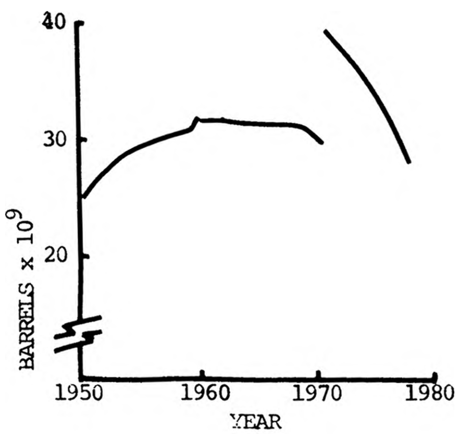

Fig. 4 U.S. oil reserves

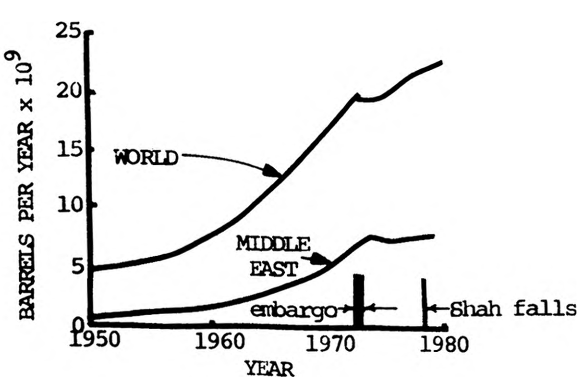

Fig. 5 Oil production trend

(All graph data from API Basic Petroleum Data Book)

(2) Fully allocated cost of production. This is equal to the sum of the marginal cost plus the fixed cost allocated to each unit of production. Fixed costs would generally include capital depreciation, taxes, insurance, debt service, base wages and salaries. In the case of crude oil, the fully allocated cost also includes the cost of lifting the product and the allocated cost of drilling and equipping the well. Moreover, the allocated cost of all drilling failures must be borne by successful production even if producers and their accountants cannot assess the cost of failure. Somehow, the market knows the cost of failure. If losers' losses exceed winners' gains, the industry will shrink and ultimately die.

(3) Cost of an available substitute. If the operator of a steam boiler can, with equal facility, burn oil or natural gas, the least expensive fuel will be burned. Even if the alternate fuel is never used, its mere existence in the market will have significant impact on the price of the fuel which is burned.

(4) Probable cost of anticipated substitute. During the time interval commencing about 1955 and ending about 1975, the market price of coal was significantly depressed by the anticipated cost of nuclear energy. For reasons beyond the scope of this paper, nuclear energy has not become a generally available substitute for coal but the anticipation of cheap nuclear energy did nevertheless, significantly depress the market price of coal for nearly 20 years.

(5) Anticipated consumption-production imbalance. Since it is difficult to quantify anticipation, there does not seem to be any objective way to measure the impact of this factor on the market. No matter. The impact is real enough. If one correlates weather forecasts in the citrus belt with prices in the orange juice futures market one can readily discern the impact of an anticipated freeze. If the forecast freeze does not materialize, however, futures prices generally return to their pre-forecast level.

(6) Actual production-consumption imbalance. This is an illusory force, analogous to that of centripetal force. There cannot exist a perpetual production-consumption imbalance. That which we perceive as an imbalance is generally associated with a measurable departure from historic production and consumption trends and by unusual inventory levels.

(7) The cost of doing without. In the extreme, a prospective consumer may have the choice of paying the asking price for a product or doing without the product or its usable substitute. This factor is rarely present in a market unless an irreplacable inventory is being exhausted. Food in a blockaded city would be an example.

4. TESTING MARKET FORCES

(1) Marginal cost of production. Marginal cost of production tends to establish a floor or lower price limit for a commodity. To sell below one's marginal cost of production is, in effect, to give away money. Marginal costs in oil production exhibit great diversity. Persian Gulf oil wells are typically a thousand times as productive as U.S. onshore wells. Accordingly, Persian Gulf marginal costs are measured in pennies per barrel whereas U.S. marginal costs are measured in dollars per barrel. In an unrestrained oil market in which world-wide newly proven reserves exceeded world consumption, market prices would tend to decline to the marginal cost of production of the largest producer. In such an hypothetical circumstance, the market price for oil would decline below the marginal cost of production in the U.S. and U. S. production would cease. This, in fact, would have occurred in the decade of the 1950s and 1960s had not the U.S. government imposed import quotas on foreign oil during these two decades when world reserves increased by about 450 billion barrels while world consumption increased from about 6 billion barrels per year to 16 billion barrels per year.

As long as world oil reserves were rising, i.e., prior to 1970. (Fig. 2) it was possible for the U.S. to sustain a two-tier market to the major disadvantage of Persian Gulf producers. As late as 1968, Persian Gulf residual oil was delivered on the U.S. east coast for less than $1 per barrel, a price far below the cost of replacing either our domestic gas or oil reserves. (By contrast, we now pay about 27 times that price, on an energy equivalent basis, for imported natural gas.) Once world oil reserves stabilized around 1970, in the face of rising world demand, world oil prices commenced to rise such that marginal production costs were no longer a limiting factor in oil markets. Hence it is apparent that marginal cost of production was not a significant factor during the price discontinuities of the 1970s.

(2) Fully allocated cost of production. Fully allocated costs of oil production include the allocated costs of geology services, drilling and equipping wells and any associated dry hole costs in addition to the marginal costs. Prior to 1973, many mature oil reservoirs in the U.S. operated between the marginal cost of production and the fully allocated cost of production.
As with marginal costs, fully allocated costs of oil production tend to establish a lower market limit. Since the price discontinuities of 1973 and 1979 involved rising prices, it is apparent that this factor, fully allocated costs, was not a significant contributor in the discontinuities.

(3) Cost of an available substitute. Although there are many potential substitutes for oil, there are relatively few available now in commercial quantities. Some central station power plants are equipped to burn either coal or oil in which case coal, with the sufferance of EPA, would be an available substitute for oil. Although free-market oil costs about six times as much as coal on an energy-equivalent basis, there has been no overwhelming rush to convert to coal. The price disparity between coal and oil reflects the limited degree to which coal can be substituted for oil.
Natural gas is a potential substitute for oil. Because U.S. reserves and production both peaked within two years of 1970, natural gas can be substituted for oil only in quite limited circumstances.[2] Economic and technical factors would permit the expanded use of coal and nuclear to offset our declining reserves and production of oil but political factors have prevented such substitutions such that our reliance upon imported oil has continued to grow. (Fig. 3) Of the many exotic sources of energy--fuel wood, tar sand, shale oil, alcohol, wind and solar--none are available now in quantity sufficient to match our declining domestic reserves. (Fig. 4)

(4) Probable cost of an anticipated substitute. Sooner or later, it appears that we must find energy sources to substitute for our finite oil and gas resources. Although we may hope for some technical development that will make solar or fusion energy practical and economic, prudence demands that we address our attention to synthetic fuels from coal and/or shale because the necessary technology is at hand and our domestic reserves of coal and shale are large. Indeed the U.S. is addressing the matter of synthetic fuel production as reflected in the table following:

TABLE 1. COSTS OR PROJECTED COSTS OF SELECTED U.S. SYNFUEL PROJECTS

Identity	Location	Est. Cost($)	Cap. (bbl/day)	Cost ($/daily-barrel*)
SRC-1	Newman, KY	1.5 billion	20,000**	75,000[3]
SRC-II	Morgantown, WV	1.4 billion	20,000	70,000 ibid
Exxon Don. S.	Baytown, TX	350 million	600	580,000 ibid
W. R. Grace	Baskett, KY	3.0 billion	55,000	54,500[4] ibid
Am. Nat. Res.	Mercer Co, ND	1.4 billion	21,000**	66,000

*One barrel per day production capacity is one daily-barrel.
**Barrel-equivalent for non-liquid fuel.

The weighted average of these costs ($/daily-barrel) is 65,000. Conventional oil, by con-contrast sells for about $35,000/d-b, although that figure is difficult to draw into focus because of the several categories of oil, arbitrary oil pricing and varying tax liabilities under U.S. "energy policy". To a first approximation, production, measured in daily-barrels, sells for about 1000 times the market value of a barrel of oil. (This relationship implies a 2.8 year payout or 36% return on investment if there were no production decline, no taxes, no insurance and no production costs.)

Although a synthetic oil plant should not be subject to the characteristic time-rate of decline in production of a natural oil reservoir, operating costs can be expected to be much higher than for production from a natural oil reservoir. To a first approximation, these factors will balance out. Hence we can expect a barrel of synthetic oil to cost about 1/1000th of the daily-barrel capacity cost. If, then, synthetic capacity costs $65,000 per daily-barrel, synthetic oil will cost about $65 per barrel as compared to about $35 per barrel for the current free-market price of natural oil. Other people may also have drawn that same conclusion. Consider the statement of OPEC deputy secretary-general, Fadhil al-Chalabi, "...world prices should eventually double to $60/bbl to bring them (oil prices) in line with synfuel prices."[5]

For the record, there are studies by reputable authorities projecting shale oil costs as low as $15/bbl.[6] If such a price proves out and if such shale production capacity can be expanded at a rate to offset the decline in U.S. conventional oil production commencing in 1970 then the world price of oil will decline to match the price of shale oil. The question remains, however, if shale oil can be produced for $15/bbl, why are we paying, on the margin, $30 to $40/bbl for the natural product?

Unfortunately, no one knows what synfuel is going to cost. Even the highest estimate cited here may be far off the mark because multi-billion dollar engineering projects have a way of escalating from 2 to 10 times if the Trans Alaska Pipeline and various nuclear projects are any guide. There is little doubt however but that the free-market is, by trial and error, pushing the price of natural crude toward the estimated cost of synthetic fuel substitutes.

(5) An anticipated production-consumption imbalance. Just as a freeze forecast will drive up the price of orange juice, the threat of an oil supply interruption will drive up the price of oil. Fig. 1 illustrates the relationship between the price of Arab Light crude and two major political events which threatened world oil supplies. (Spot oil prices were somewhat more volatile than the prices reflected in Fig. 1 but these prices have, nevertheless, tended to stabilize near the the price of Arab Light.

Anticipation undoubtedly accounts for the sharp runup in oil prices in 1973 and 1979 but it does not explain what held oil prices at these lofty levels. (It is worth recalling that Saudi Arabia embargoed oil to the U.S. during the Arab-Israel war of 1967 also but that embargo was ineffective because U.S. production was rising as fast in 1967 as it was falling in 1973 and we were not importing enough Arab oil to make much of an impact in the U.S. oil market.)

(6) An actual production-consumption imbalance. If the anticipation of shortened supplies drove the price of oil up in 1973 and 1979, did subsequent events confirm the anticipation to account for the quasi-stable newly higher prices? Table 2 indicates that world oil production was scarcely perturbed during either the 1973-74 Arab oil embargo or the 1979 turmoil in Iran.

TABLE 2. SELECTED OIL PRODUCTION DATA, ($x\ 10^9$ BBL/YEAR)[7]

YEAR	MIDDLE EAST	REGION FREE WORLD	TOTAL WORLD
1972	6.63	16.35	18.60
1973	7.45	16.76	20.37
1974	7.99	16.54	20.54
1978	7.88	17.20	22.16
1979	7.80	17.64	22.77

It is true that Iranian production of oil has fallen from nearly 6 million barrels per day in 1974 to essentially zero at the present time but increased production rom other countries or regions more than made up for the loss of Iranian oil. (Fig. 5) Hence we must look elsewhere for the cause of the sustained high prices for oil in the 1970s.

(7) Cost of doing without. The cost of an abrupt loss of liquid fuel supply would be the collapse of western industrial society. In the short run, if we lose our liquid fuel supply, we lose all of our engineered energy. Without liquid fuel we cannot mine or transport coal, operate nuclear power plants, transport fertilizer, cultivate the land or transport and process human food. We would be forced to decentralize and resort to a subsistence type society such as characterized by the frontier settlers in North America 150 years ago. The cost, to the extent it could be measured in dollars might be the collapse of the GNP (gross national product) from $2.2 trillion to perhaps $0.2 trillion (still leaving us affluent compared to the really poor societies of the world). Thus the loss of the 6 billion barrels of oil we, in the U.S., consume each year would cost us $2 trillion or about $330 per barrel.

Man is adaptive and ingenious. Given the abrupt loss of liquid fuel, we would undoubtedly suffer greviously in the short run but we would surely learn to accommodate to the new life if we could avoid major civil strife while adapting. Meanwhile, $330 per barrel for oil represents an hypothetical upper limit on oil price.

5. CONCLUSIONS

Examination of the market forces or limits cited here suggests that the absolute boundaries for oil prices are: marginal cost of production on the low side and cost of doing without on the high side. The more practical boundaries are the fully allocated cost of production (lower limit) and the probable cost of an anticipated substitute (upper limit). As it turns out, the spread between these latter limits is quite wide for most oil production today. The actual price of crude oil today lies in the middle of that spread but trending upward until, 1) world reserves stabilize or 2) large-scale commercial production of snythetic oil is demonstrated at or below the current price of oil. What should U.S. government energy policy be to assure a continued economic supply of liquid fuel? The answer: NOTHING, the government has done too much already. Without intending to condemn everything government has done in the energy field, there follows a short list of some of our government's achievements in energy:

--Subsidized oil when it was cheap and plentiful

--Discriminatorily taxed oil when it is scare and dear

--Killed a negotiated deal for $2.60/Mcf natural gas from Mexico

--Negotiated a substitute contract for Mexican natural gas at $4.47 plus escalators

--Mandated the sale of domestic natural gas at less than its replacement cost thus

-Encouraging the construction of 30 million dwellings with uneconomic insulation

-Encouraged burning of natural gas for boiler fuel

-Beggared the domestic coal industry by forcing competition with cheap gas

-Drove U.S. oil exploration efforts abroad

--Generated panic and long lines by intruding in the administration of gasoline distribution

In short, the governmental itch to regulate has turned an energy supply challenge into an energy supply crisis and greatly heightened the risk of war in the bargain. Whatever the defects of the competitive free market and capricious though it is, the free market will ultimately recognize and correct its mistakes while bureaucratic administrators will ride them to the grave.

Scholars and observers have been predicting oil and natural gas shortages for more than 100 years. No one doubts that world reserves and production will ultimately peak and then commence an inevitable decline but in fact no one knows when this peak will come if the free market is given rein. By contrast, administered markets have already induced an artifical peak in reserves and production. A recent response to more realistic oil and natural gas prices has slightly strengthened fluid fuel reserves and production but what the government giveth the government taketh away. The "windfall profits" tax means that some of our most successful oil producers remit nearly 90% of a barrel of oil revenue to the government. We are punishing successful oil producers when we should be rewarding them. If government forces premature conversion to synthetic fuel we will be greviously punished. Consider, for example, the Mercer Co., ND Synthetic gas plant. The forecast capital cost is $66,000 per daily-barrel-equivalent. If the relationship between fuel price and capacity price set forth in paragraph 4.(4) is valid, it means that the product will cost $10/Mcf. To speak of energy costs in $/d-b or Mcf may seem abstract but we can make the case in "real world" terms: suppose your home heating bill was $150 last January, and suppose further that some winter soon you must use synthetic gas from the Mercer Co. plant at $10/Mcf. Your monthly gas bill will have gone to $750.

Whether a few of us pay a lot or many of us pay a little, we will somehow have to pay for the Mercer Co. plant by paying a fantastic premium for its gas over what free-market domestic gas would cost or contracted imported gas from Mexico or Canada would cost ($4.47/Mcf).

The market, in its wisdom, is trying to price petroleum at a level matched to the cost of developing our future energy supplies, whether natural or synthetic. Our government, in the name of consumer protection, is trying to tax away that pool of capital represented by the "windfall" on unproduced but proven reserves. For both strategic and economic reasons, our government should be trying to stimulate the expansion of economic fuel reserves. In fact, the government is suppressing the expansion of economic reserves and encouraging the expansion of uneconomic (synthetic) reserves in the questionable belief that there is no more oil or gas to be found at any price.

If we are "out" of natural oil and gas reserves, a profit-driven industry will discover that fact soon enough, the price of remaining natural reserves will rise to the synthetic replacement cost and industry will make the timely transition. If, on the other hand, we are not out of natural reserves, the consequence of government coerced, premature transition will be privation for all.

1. Doane's Agricultural Report, 148.2
2. API (American Petroleum Institute) Basic Petroleum Data Book, Section XIII
3. Barron's National Business and Financial Weekly, Aug. 11, 1980
4. Fortune, Oct. 6, 1980, pg. 48-49
5. Oil & Gas Journal, Sept. 8, 1980, pg. 3
6. Oil & Gas Journal, June 16, 1980, pg. 56
7. API Basic Petroleum Data Book, Section IV

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