



# RETHINKING SUPPLY CURVES

GHSP

APRIL 8, 2014

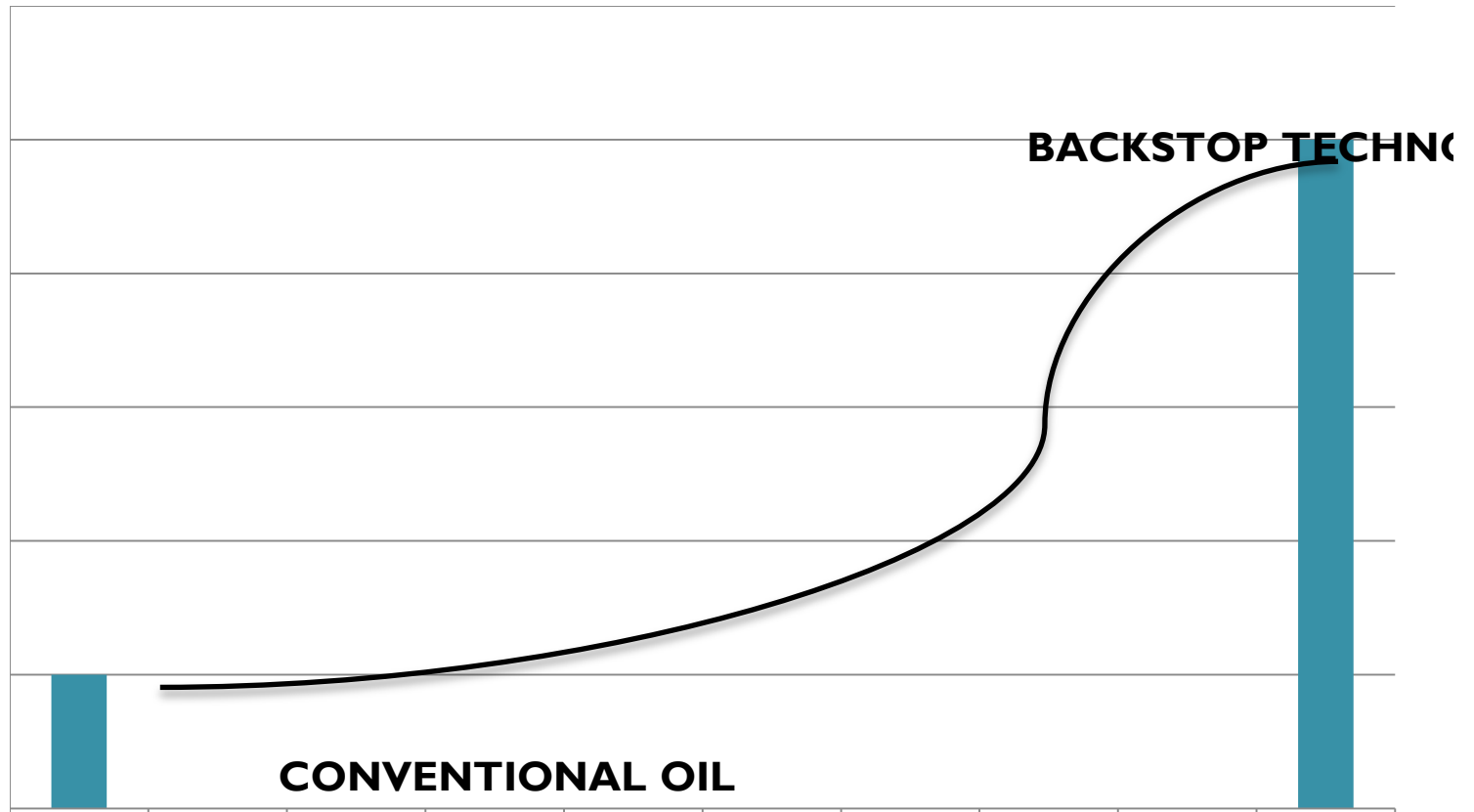
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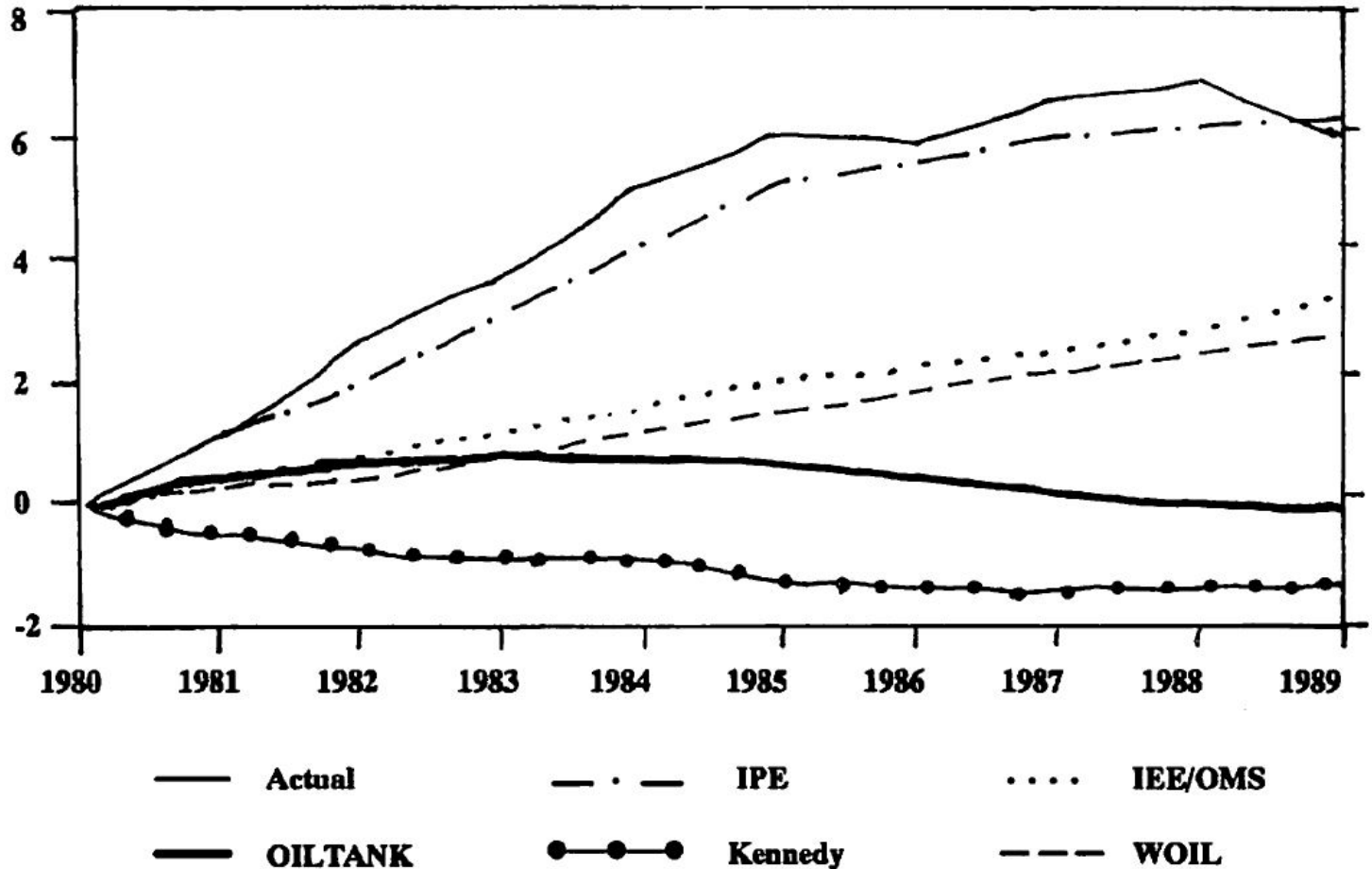
# RESOURCE ECONOMICS 101

- “DIMINISHING RETURNS ARE OPPOSED BY INCREASING KNOWLEDGE, BOTH OF THE EARTH’S CRUST AND OF METHODS OF EXTRACTION AND USE. THE PRICE OF OIL, LIKE THAT OF ANY MINERAL, IS THE UNCERTAIN FLUCTUATING RESULT OF THE CONFLICT.”  
ADELMAN, 1986

# EARLY “MODEL”



# A SIMPLE MODEL SUCCEEDS

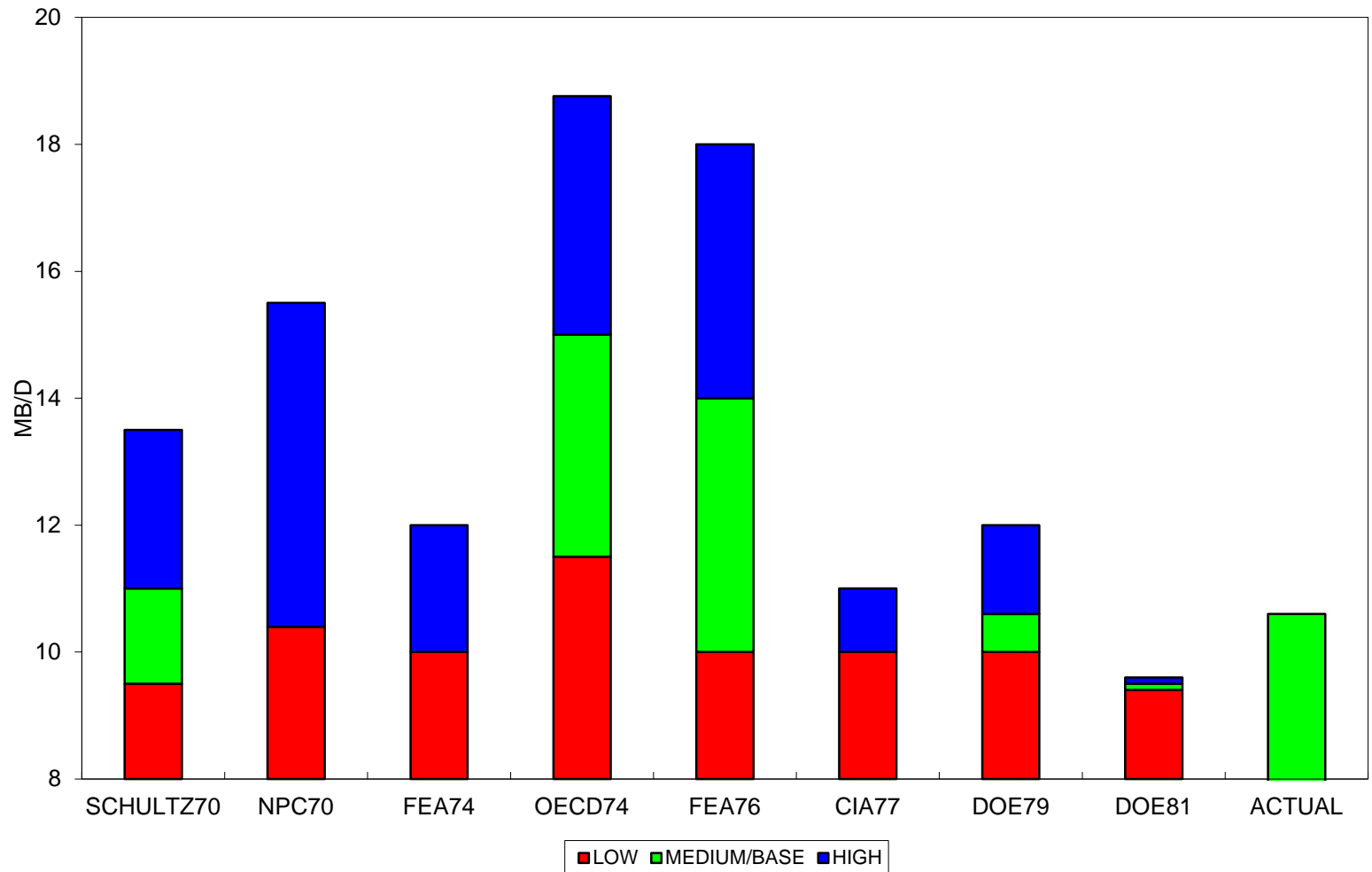


DEPLETION AND PRICE ELASTICITIES: EMF6 1982

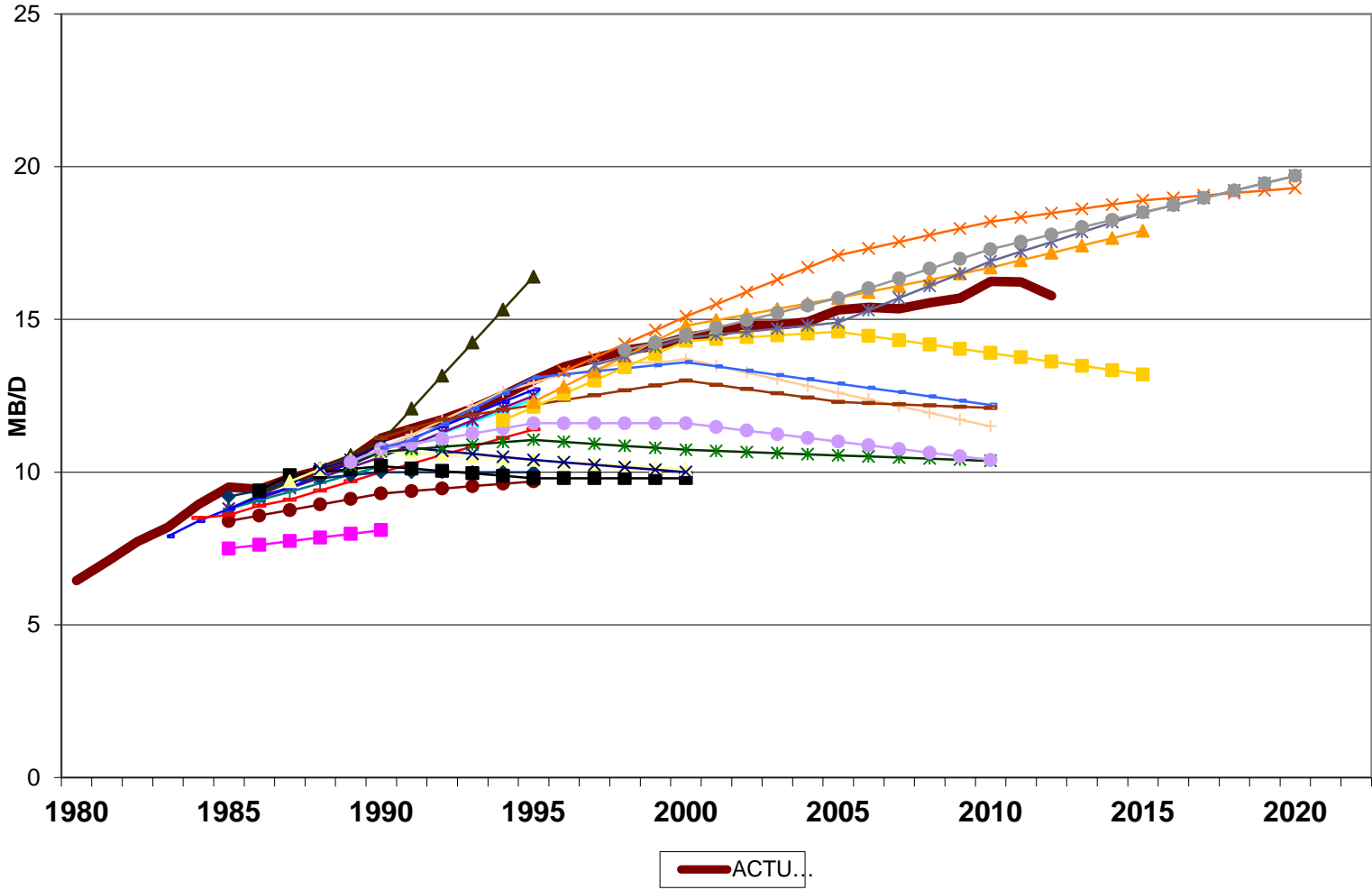
# EVOLUTION OF EXPECTATIONS

- PRE-1973: OPTIMISM
- 1973-78: DEBATE
  - $P_e=0.3$
  - MIT, CIA, WEC
- 1979-1998: PESSIMISM
- 1999-200?: OPTIMISTS TRIUMPHANT
  - AND WRONG
- NOW: BACK TO THE FUTURE?

# FORECASTS OF 1985 US OIL PRODUCTION



# DOE LDC FORECAST



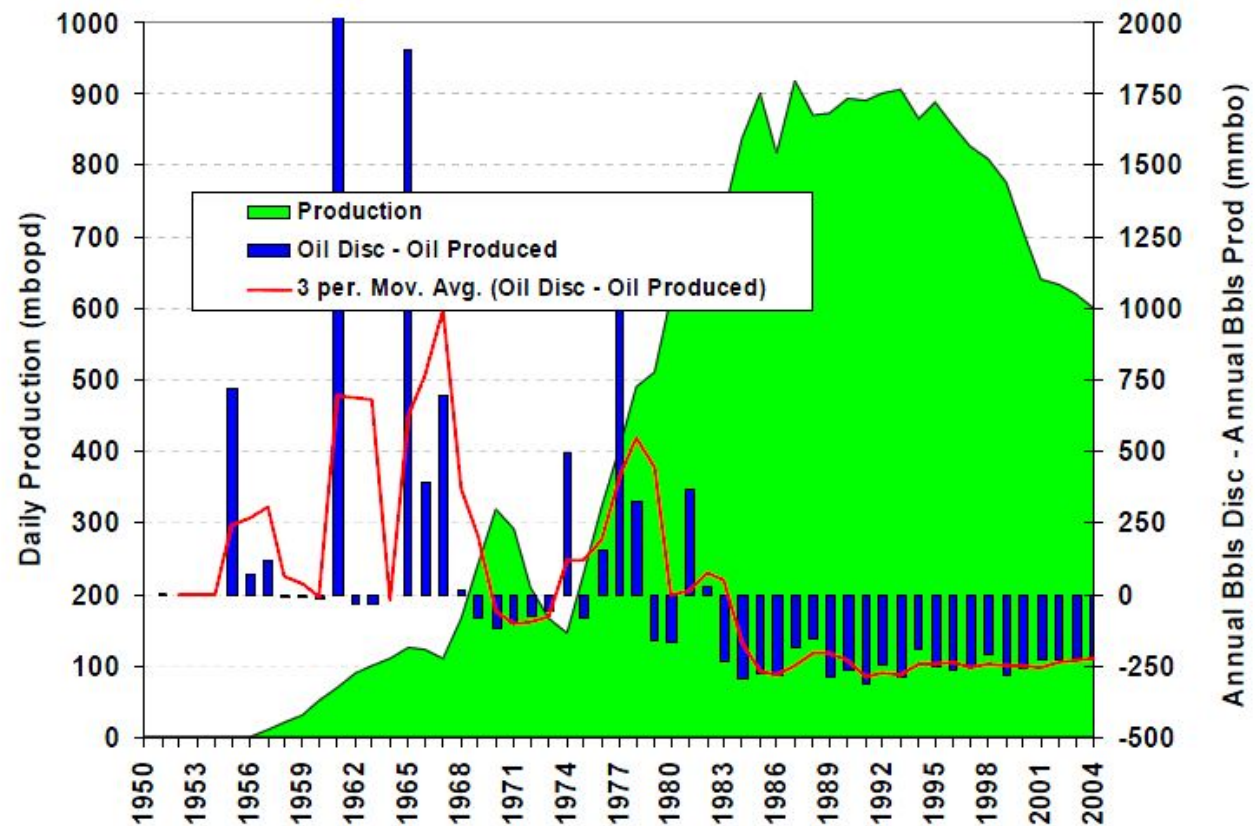
# METHODS

- PRICE ELASTICITY
  - IGNORES COSTS, TAXES
- GEOLOGICAL
  - IGNORES ALMOST EVERYTHING
- RETURN TO DRILLING
  - THEORY IS GOOD, REALITY NOT SO MUCH

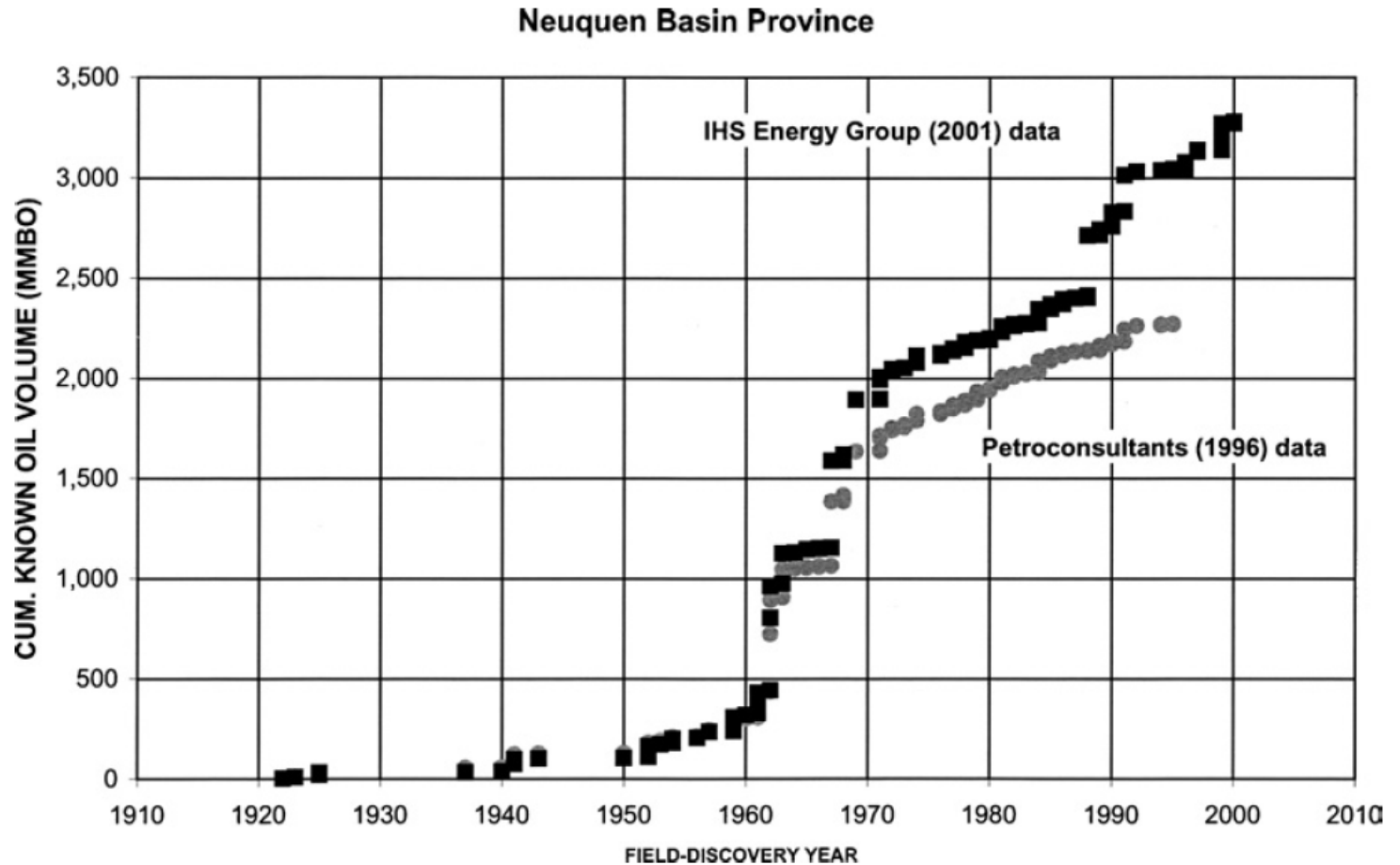


# CURVE FITTING

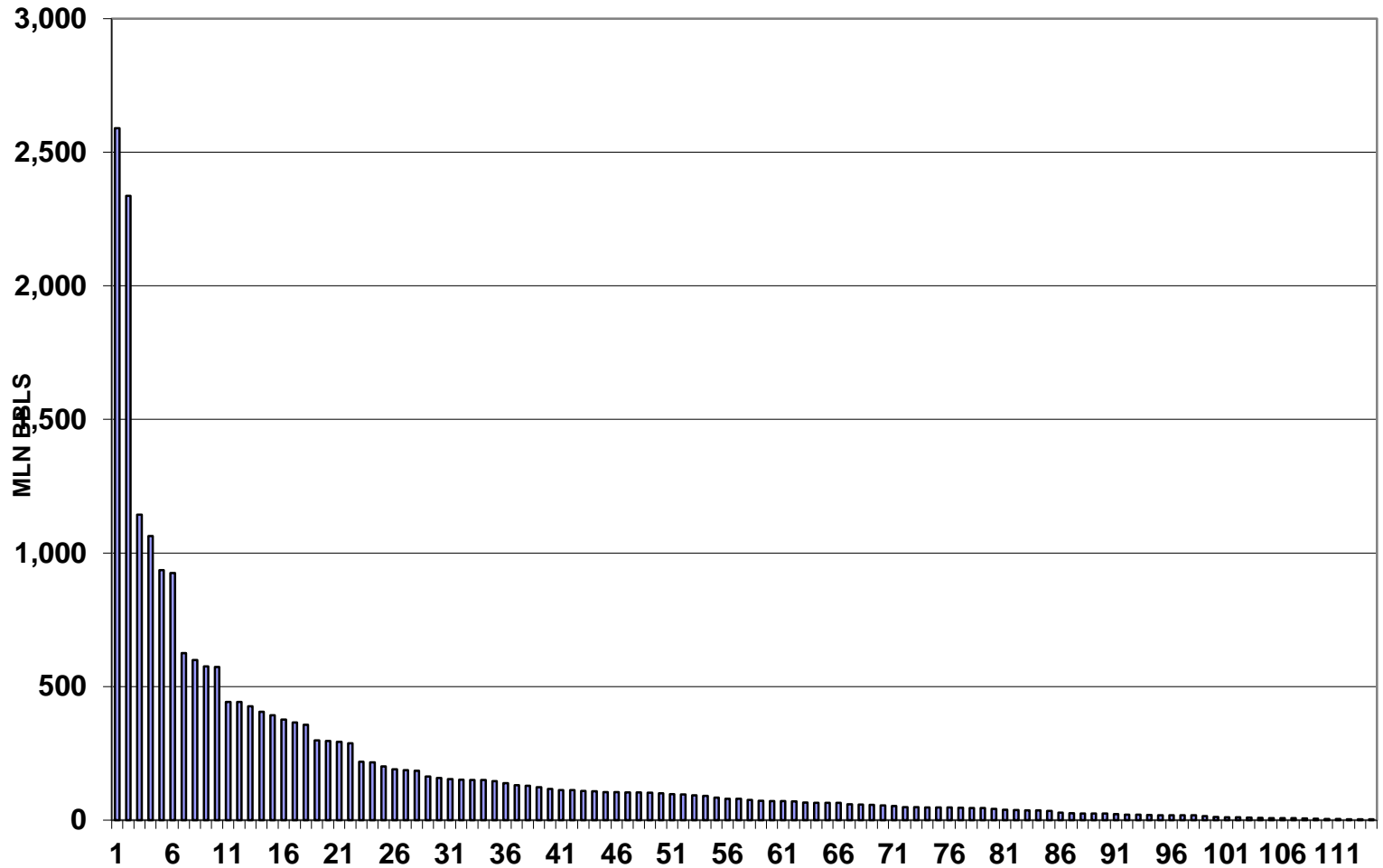
## Egypt – A Typical Life Cycle for an Oil Producing Country



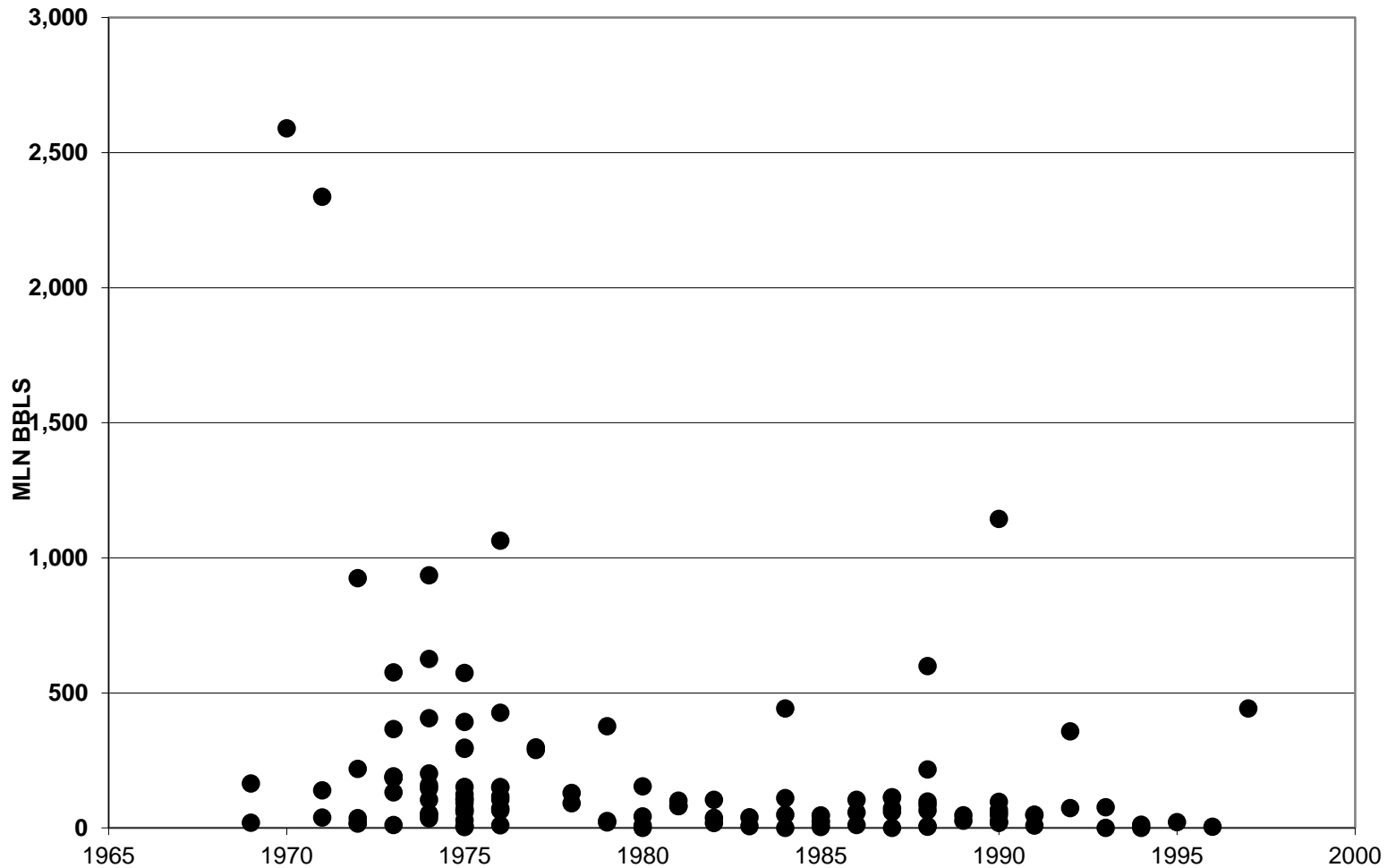
# UNRELIABLE RESERVE DATA



# UK DISCOVERIES: CURVE FITS

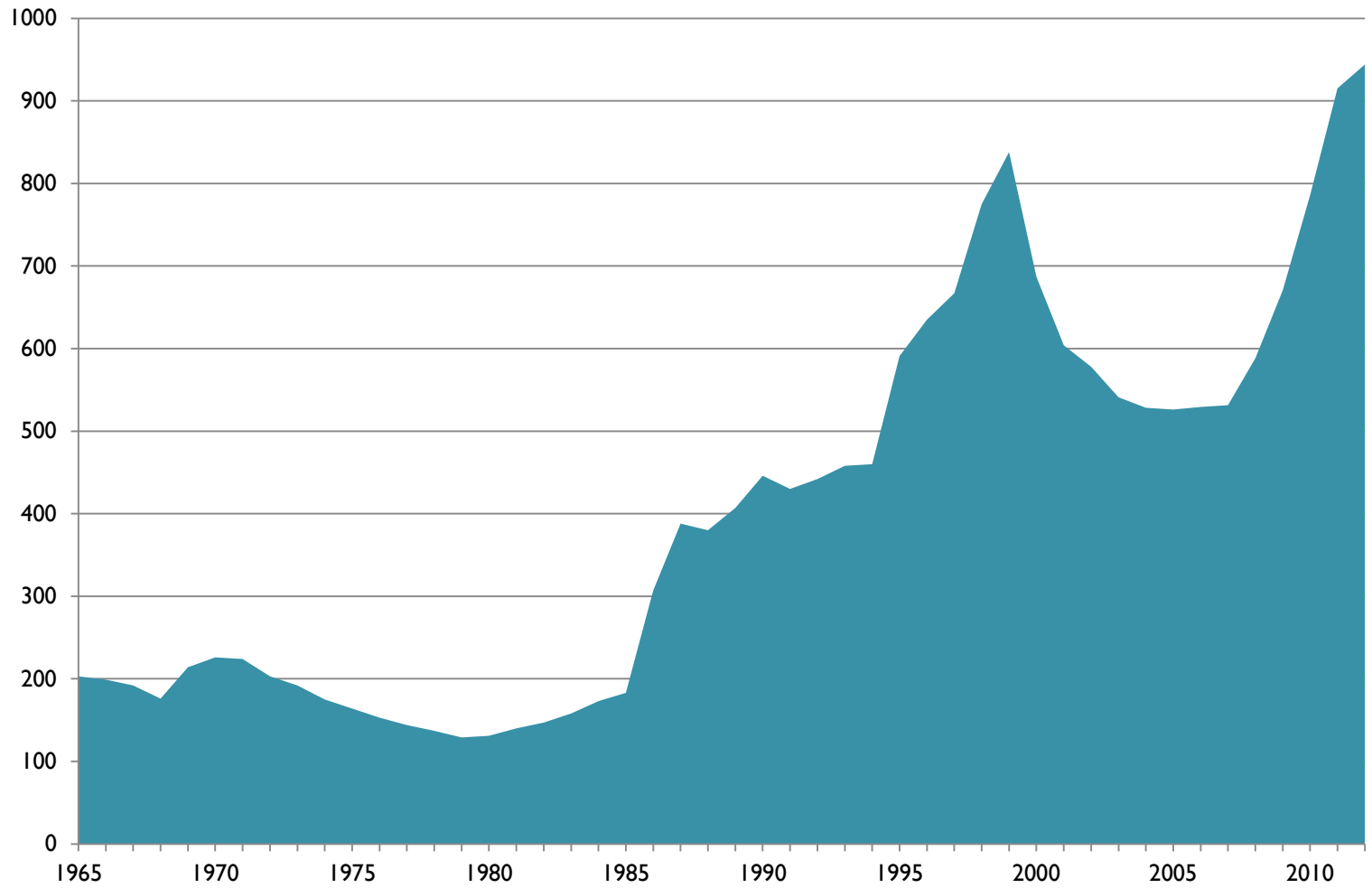


# ...BUT ONLY IF YOU MAKE IT



UK DISCOVERIES BY DATE

# POLITICS: COLOMBIA

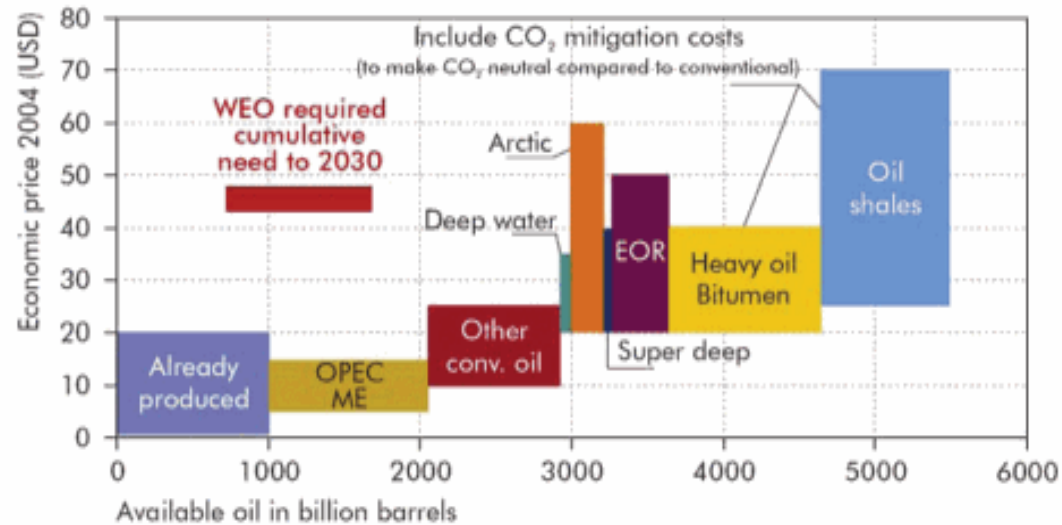


# MISREADING SUPPLY CURVES

- SHORT-RUN MARGINAL COST EXCLUDES CAPITAL COSTS
- CAPACITY CURVES USUALLY FULL REPLACEMENT COST
- HIGHEST COST IS USUALLY AN OUTLIER
- REPLACEMENT IN THE MIDDLE, NOT THE RIGHT HAND SIDE
- LARGE INCREMENTS OVER THE HORIZON FOR MANY

# INCOMPLETE RESOURCE CURVE

Figure 1. Oil Cost Curve, Including Technological Progress: Availability of Oil Resources as a Function of Economic Price

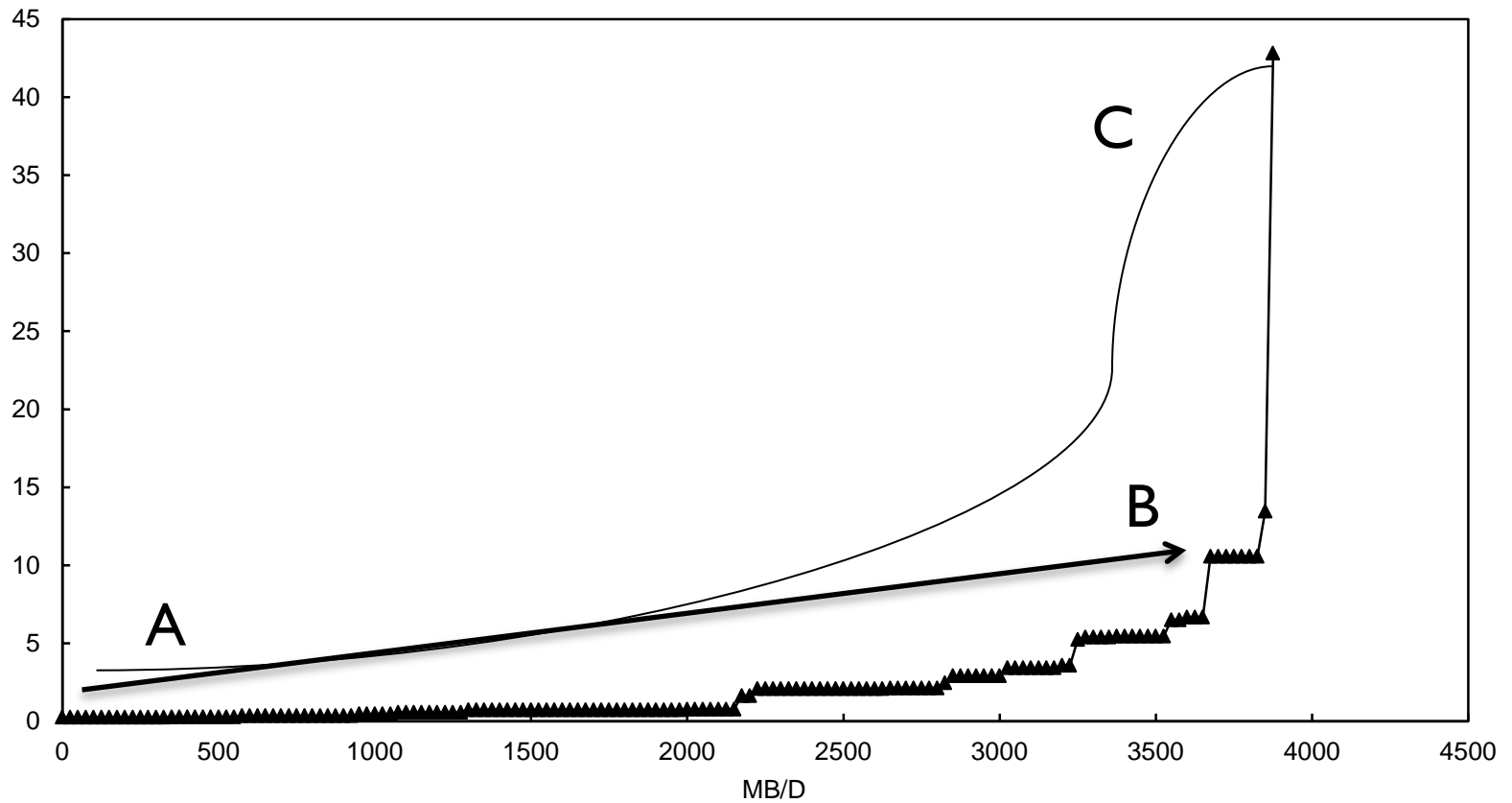


The x axis represents cumulative accessible oil. The y axis represents the price at which each type of resource becomes economical.

Source: IEA.

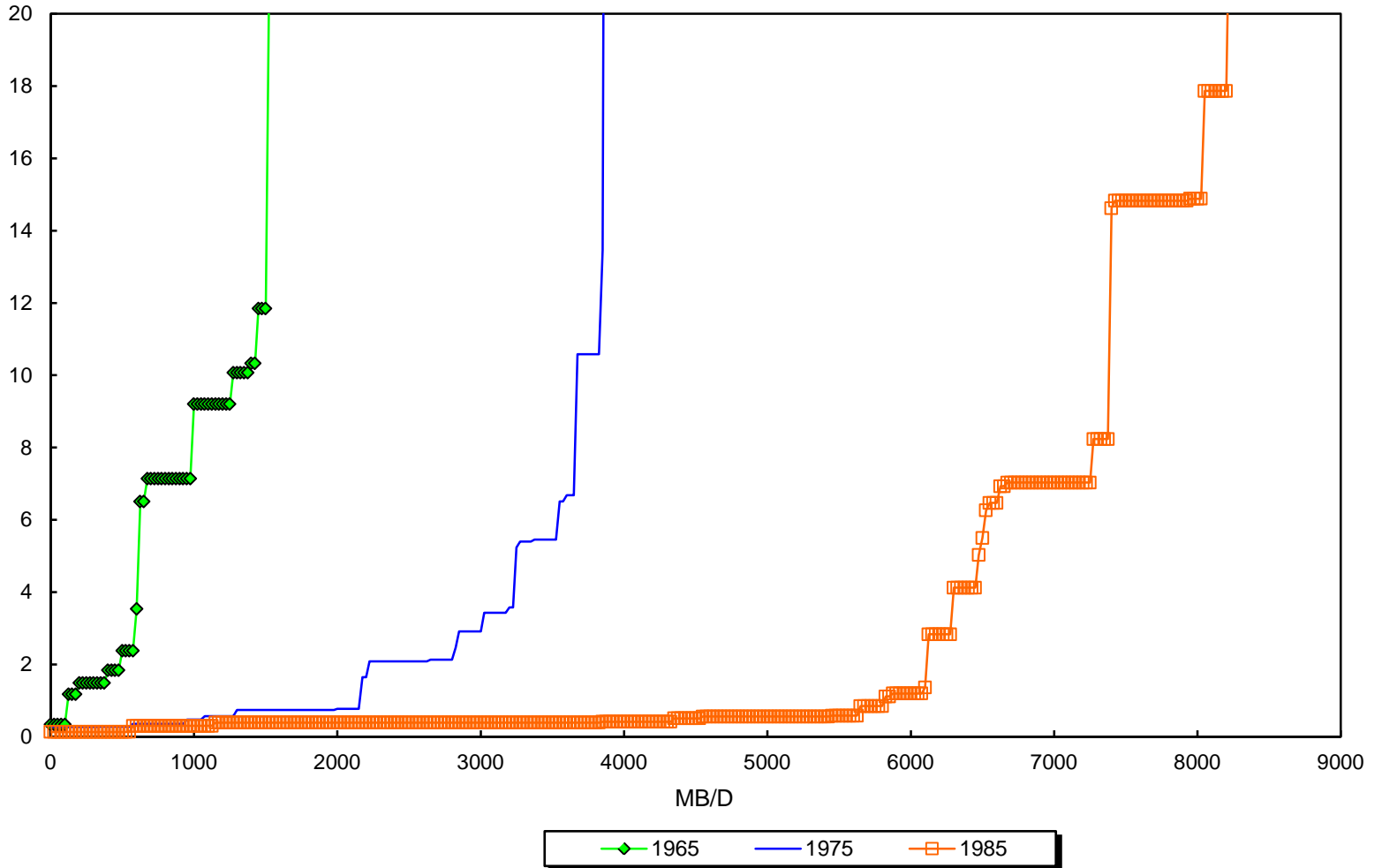
# CURVE IS ACTUALLY FLAT

NON-OPEC THIRD WORLD SUPPLY CURVES

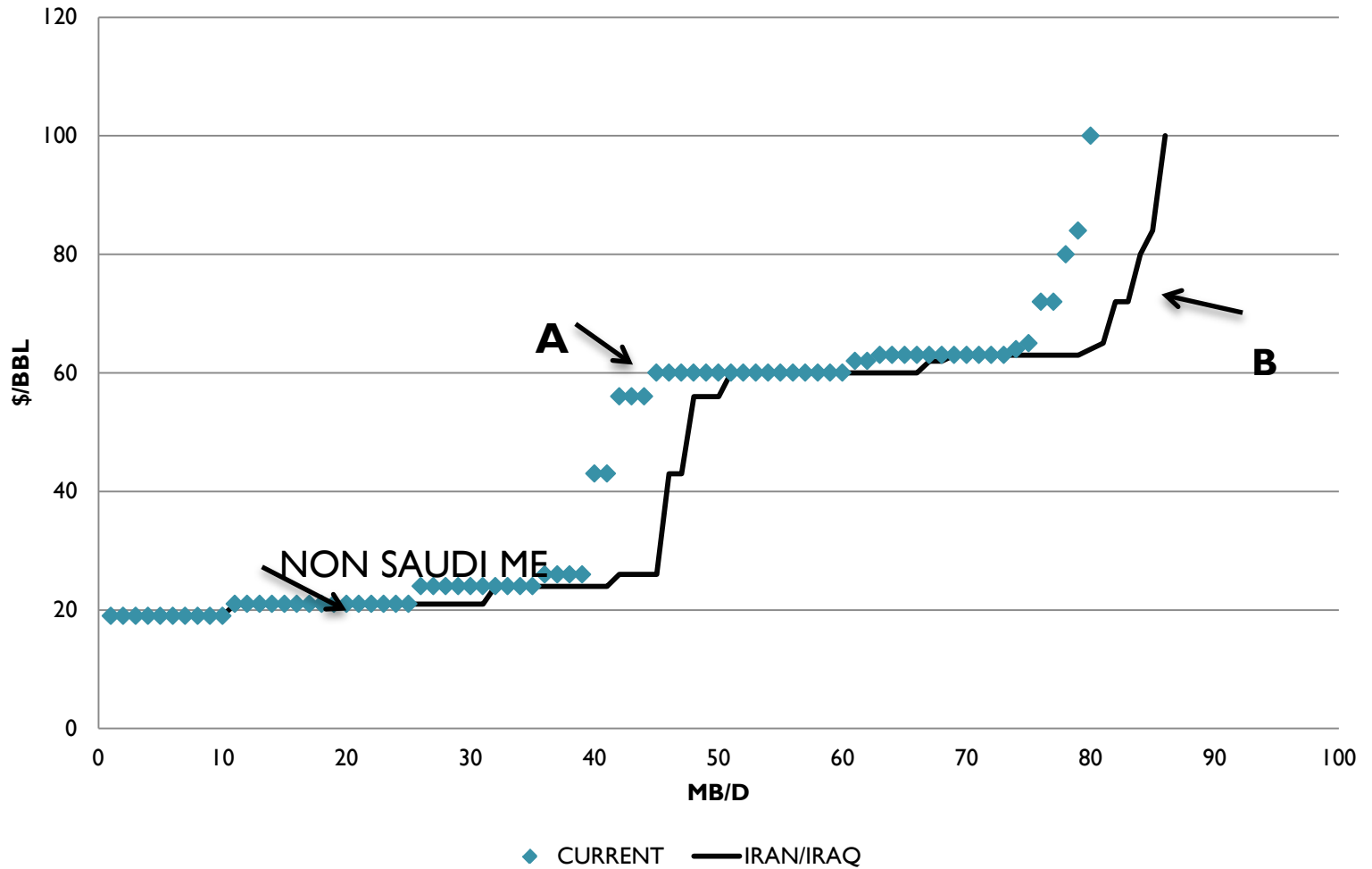




# THIRD WORLD SUPPLY: INFRASTRUCTURE/ACCESS EFFECT

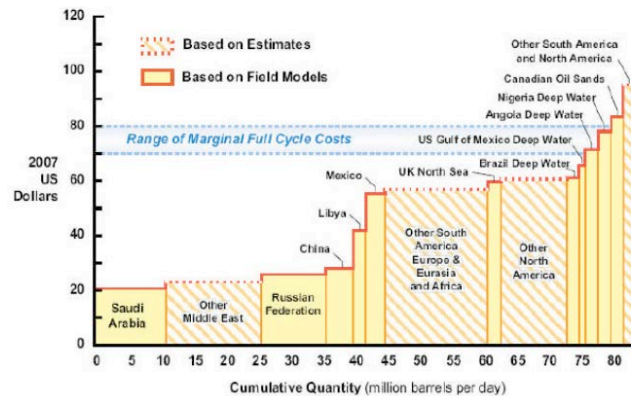


# EXPANDING IRAQ/IRAN



# SUSPICIOUS INCREASE

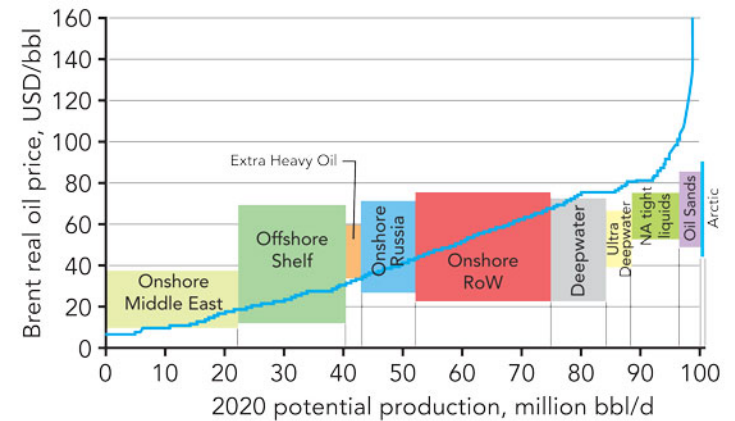
## Oil Supply Costs



Source: Cambridge Economic Research Associates "Ratcheting Down: Oil and the Global Credit Crisis" October 2008

Horizon Oil

Fig. 6: COST OF SUPPLY CURVE FOR GLOBAL OIL 2020



Note: Future oil prices will be determined by marginal cost of developing new oil rather than OPEC interventions. North American shale will out-compete many oil sands and arctic oil projects.

Source: UCube by Rystad Energy

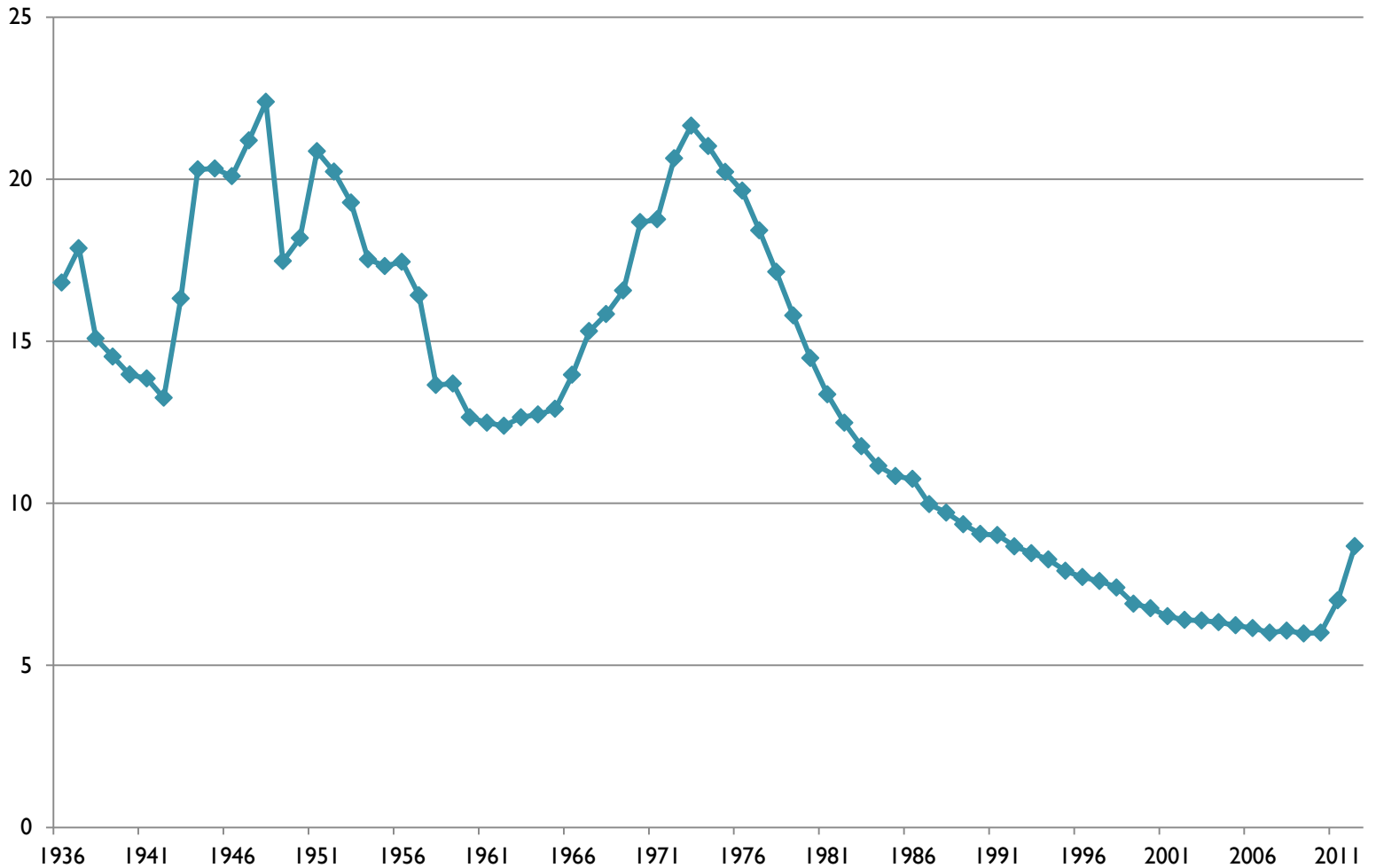
# A NEW MODEL

- RESOURCE CURVE: COST AND AMOUNTS
- RESERVES FROM RESOURCES
- CAPACITY FROM RESERVES

# RESOURCE CURVE: INPUTS

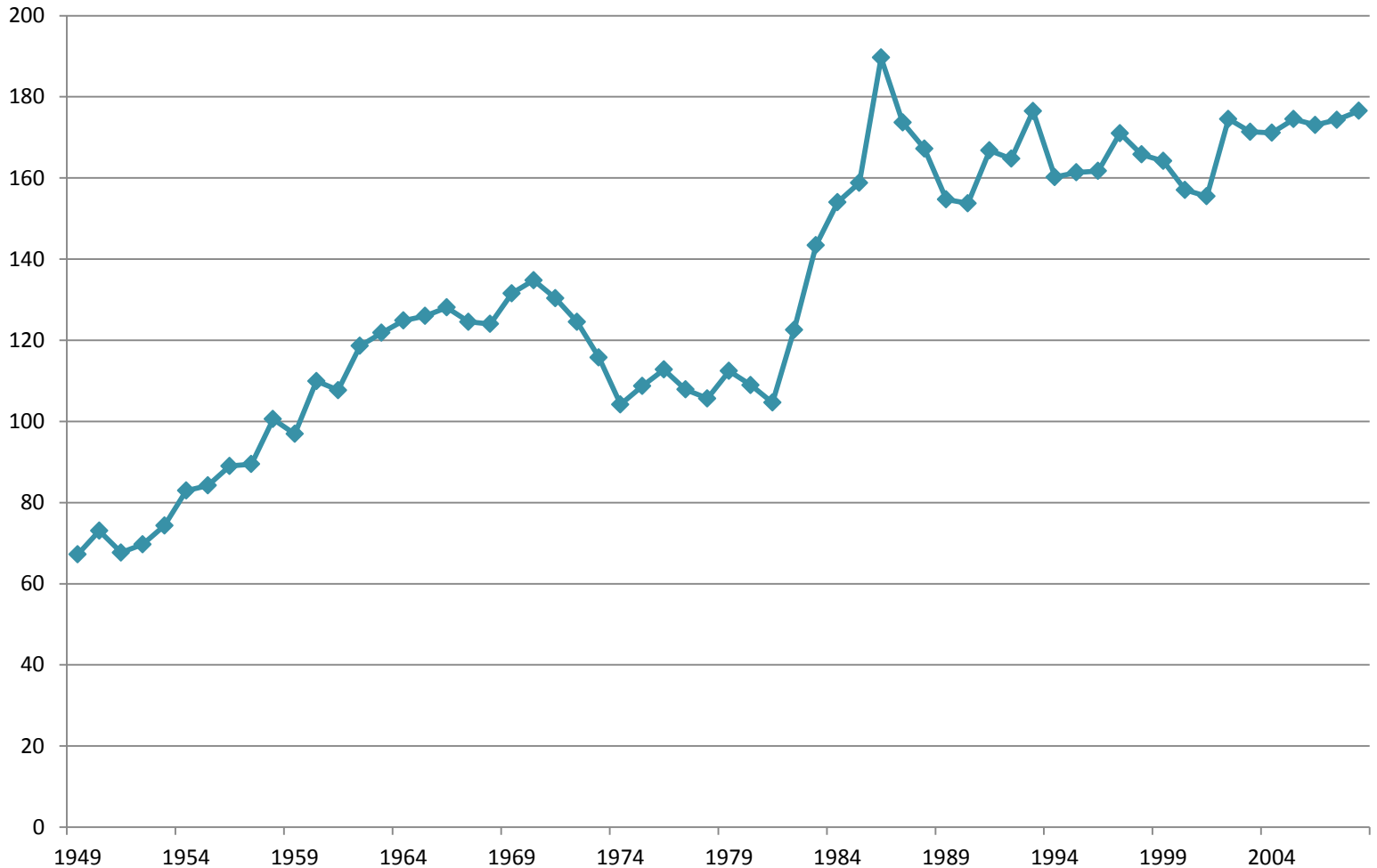
- INTERCEPT
- DEPLETION
- CYCLICAL
- TECHNOLOGICAL PROGRESS
  - BASIC AND REVOLUTIONARY
- INFRASTRUCTURE
- LEARNING CURVE
- REGULATION

# PRODUCTION PER WELL TEXAS

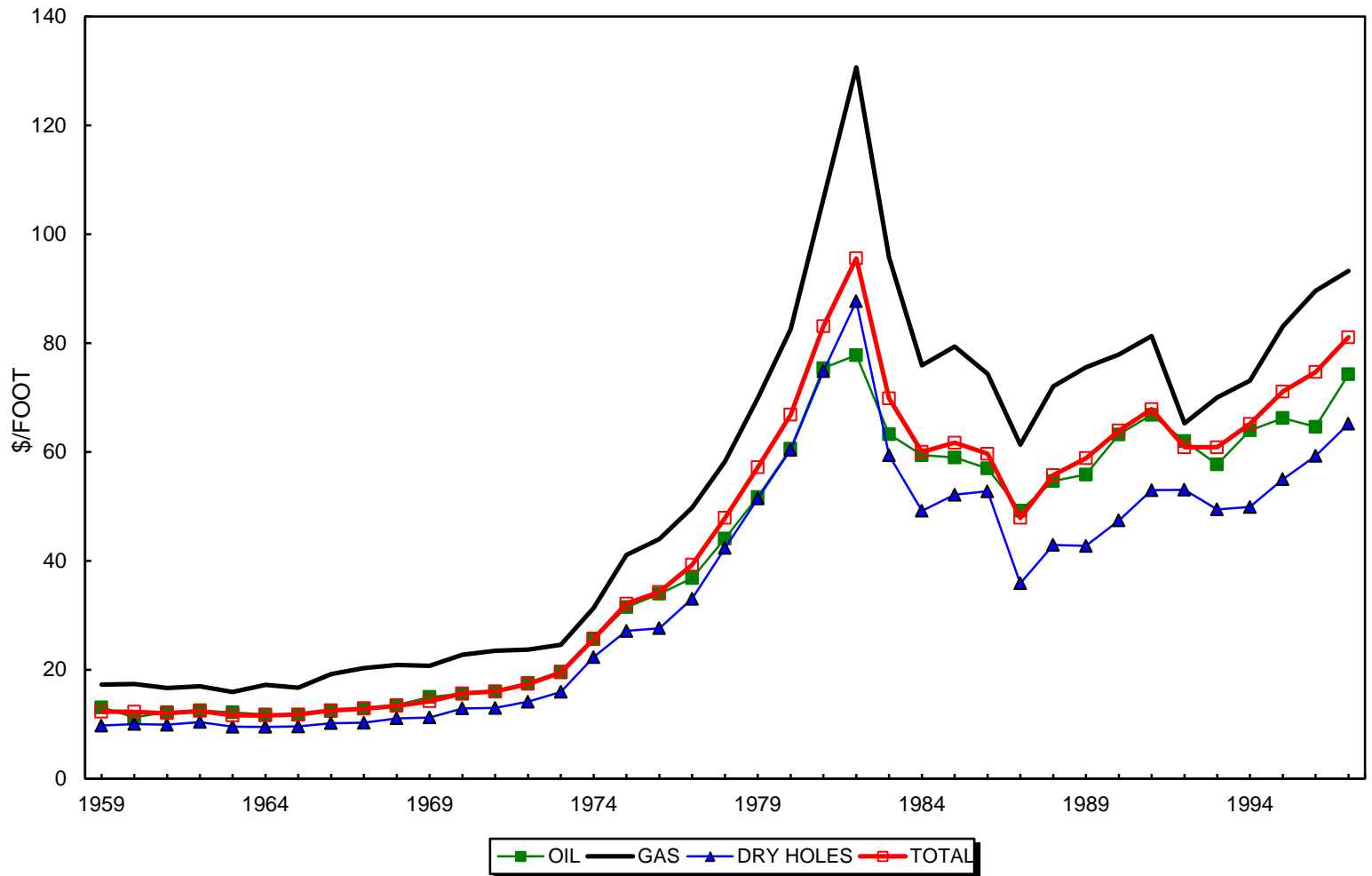


# PRODUCTIVITY IMPROVEMENT

## 000 FEET/RIG YEAR

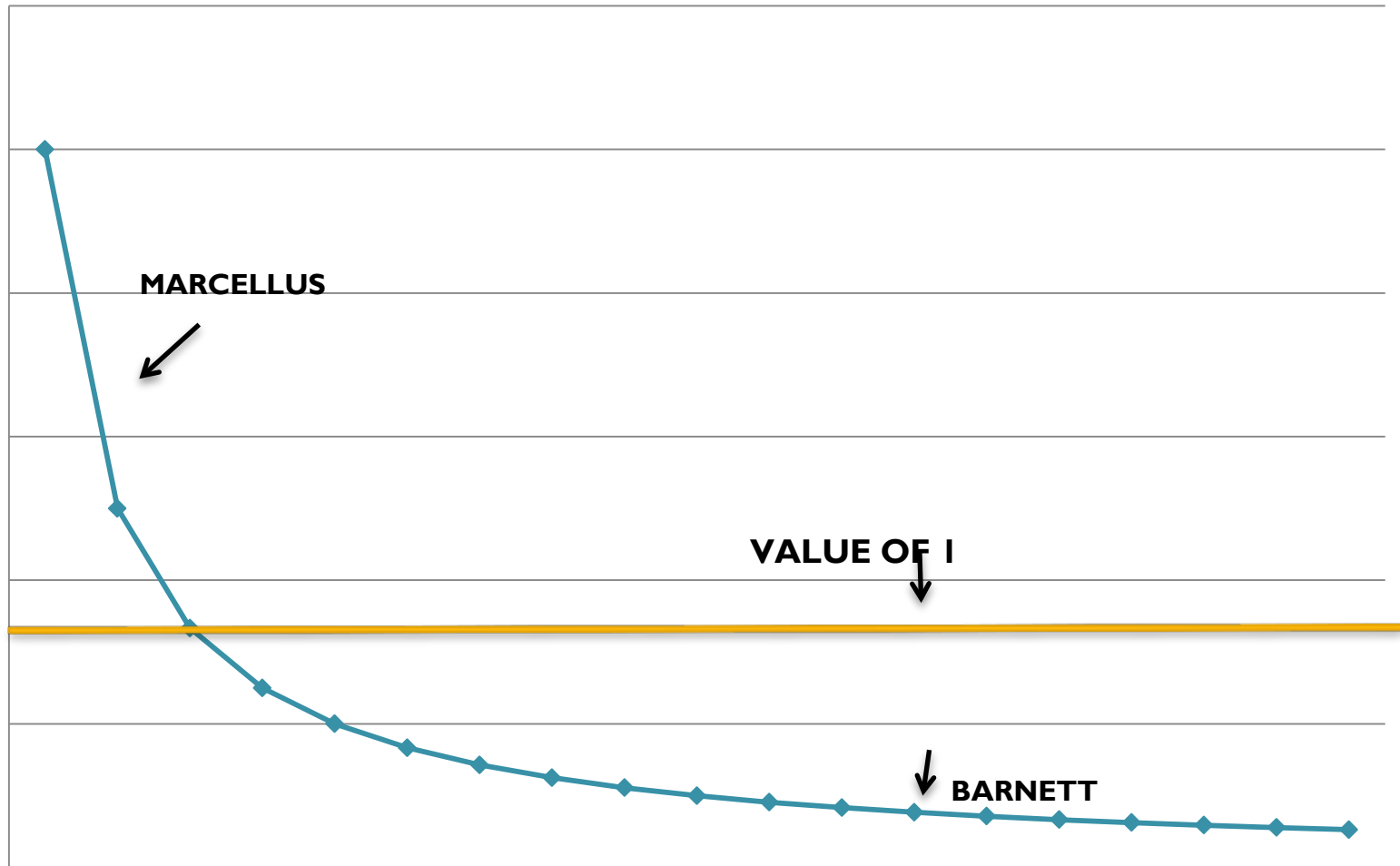


# CYCLICAL: COST/FOOT US





# INFRASTRUCTURE



# ROUGH PARAMETERS

		US	Saudi Arabia	E. Africa	Shale Oil in US
Geology	b	High	Low	Medium	Medium
Decline Rate	c	High	Low	Medium	Low
Technology	d	Low	Low	Low	High
Infrastructure	e	Low	Low	High	Low
Regulation	f	High	Low	Low	High

# RESOURCES TO RESERVES

- INVESTMENT
- PRICE/COST MULTIPLIER
  - INCLUDING FISCAL TERMS
- **POLITICAL CONSTRAINTS**

# RESERVES TO CAPACITY

- DEPLETION/PRODUCTION
- INVESTMENT
  - COST/DB
  - PRICE/COST MULTIPLIER
  - OIL REVENUE MULTIPLIER?
- **POLITICAL CONSTRAINTS**

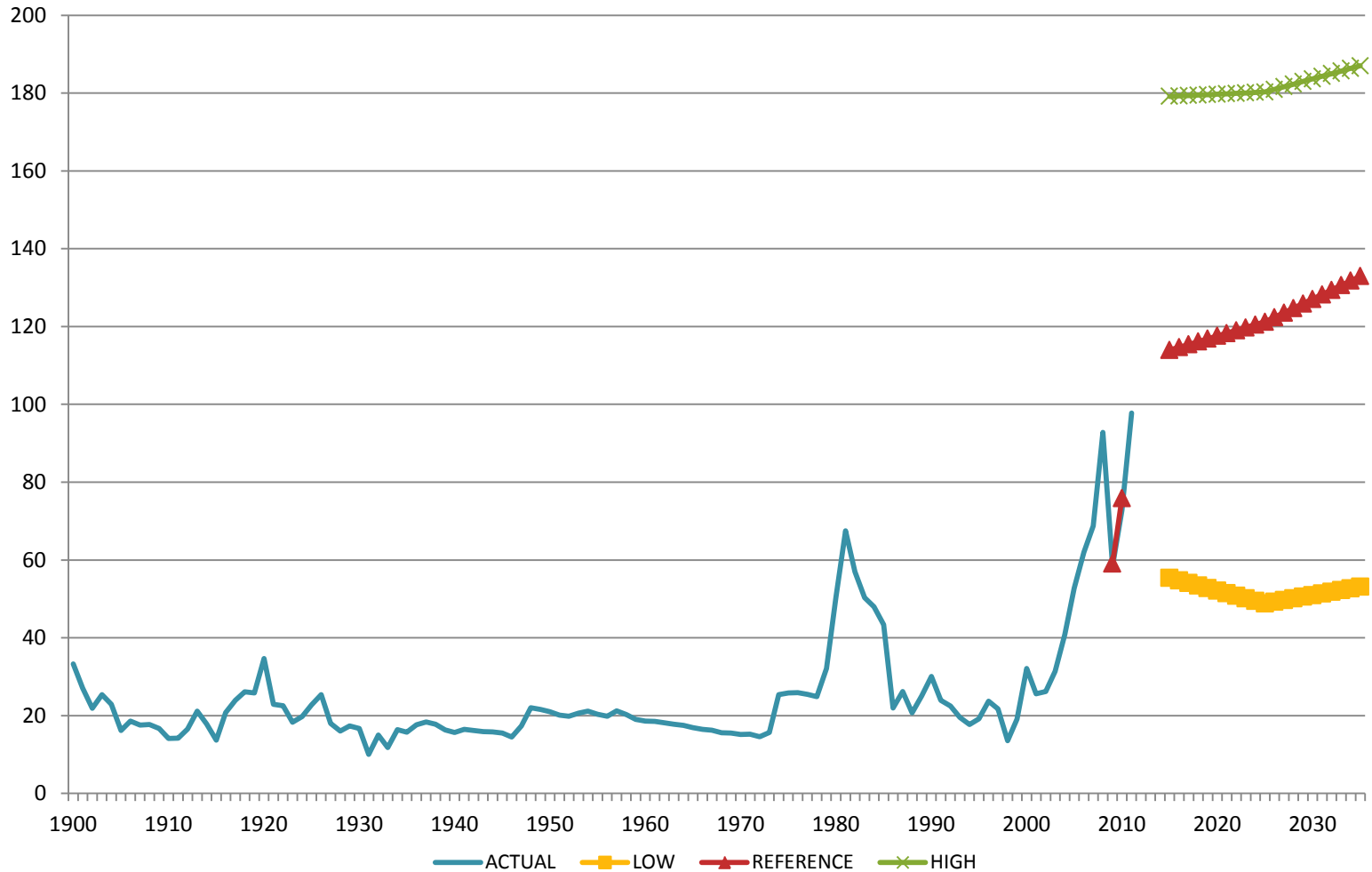
# POLITICAL MODELS

- CYCLICAL
  - GRAND POLITICAL CYCLES
  - OIL PRICE CORRELATION
    - RESOURCE NATIONALISM POSITIVELY CORRELATES WITH OIL PRICES
      - OR MAYBE NOT
- REVENUE NEEDS
  - EG COLOMBIA
- RANDOM
  - DUMMY VARIABLES FOR POLITICIANS

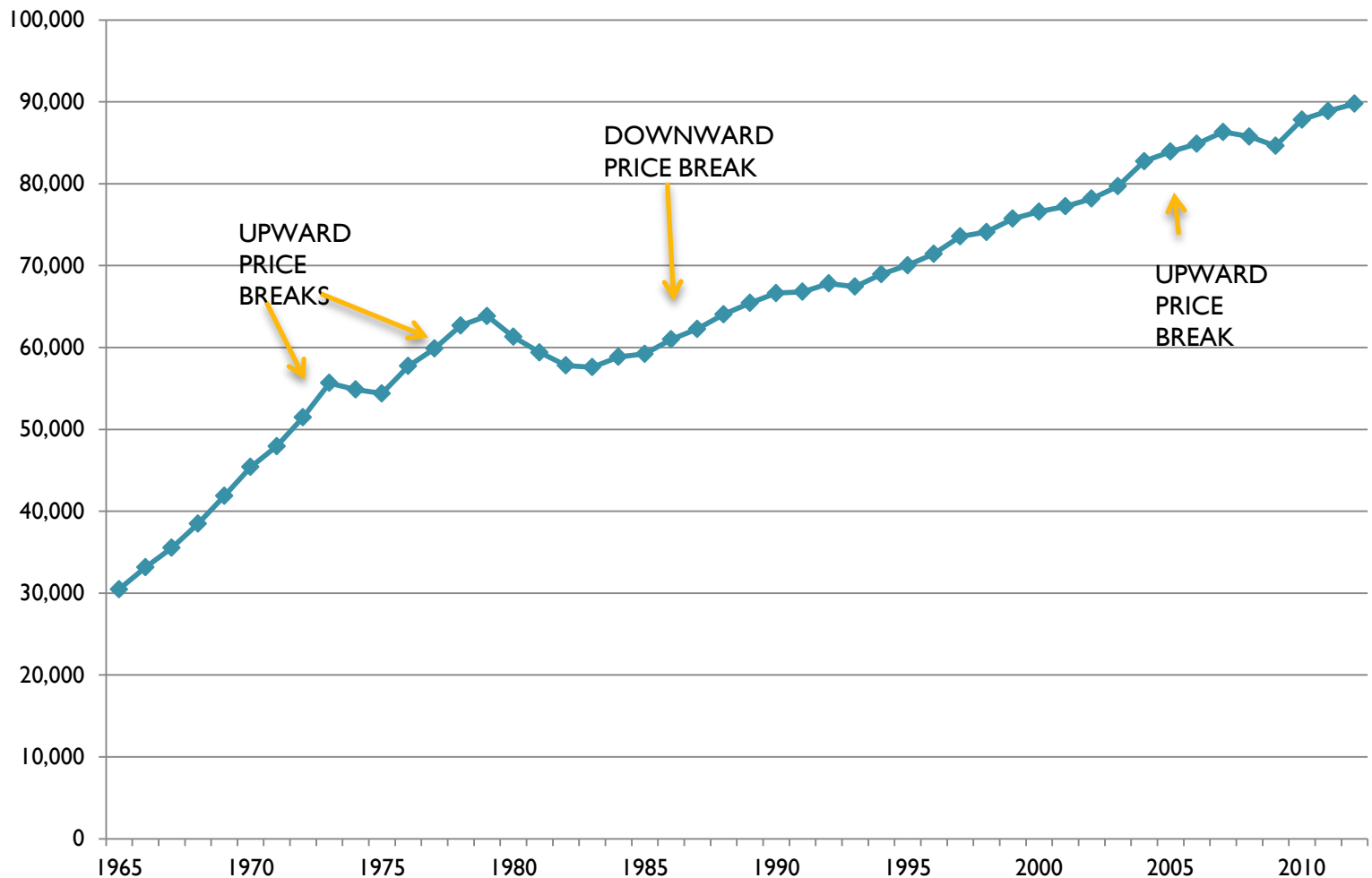
# HIGH COSTS DO NOT GUARANTEE HIGH PRICES

- FUNDAMENTAL COSTS PROBABLY HAVEN'T TRIPLED IN 10 YEARS AFTER 150 YEARS OF STABILITY
- CYCLICAL FACTORS
  - LABOR, EQUIPMENT, STEEL
- LOWER PRICES MEANS:
  - ABANDON EXPENSIVE PROJECTS
  - FALLING INPUT COSTS
  - FALLING TAXES

# PRICE EXPECTATIONS FAR BEYOND HISTORICAL EXPERIENCE

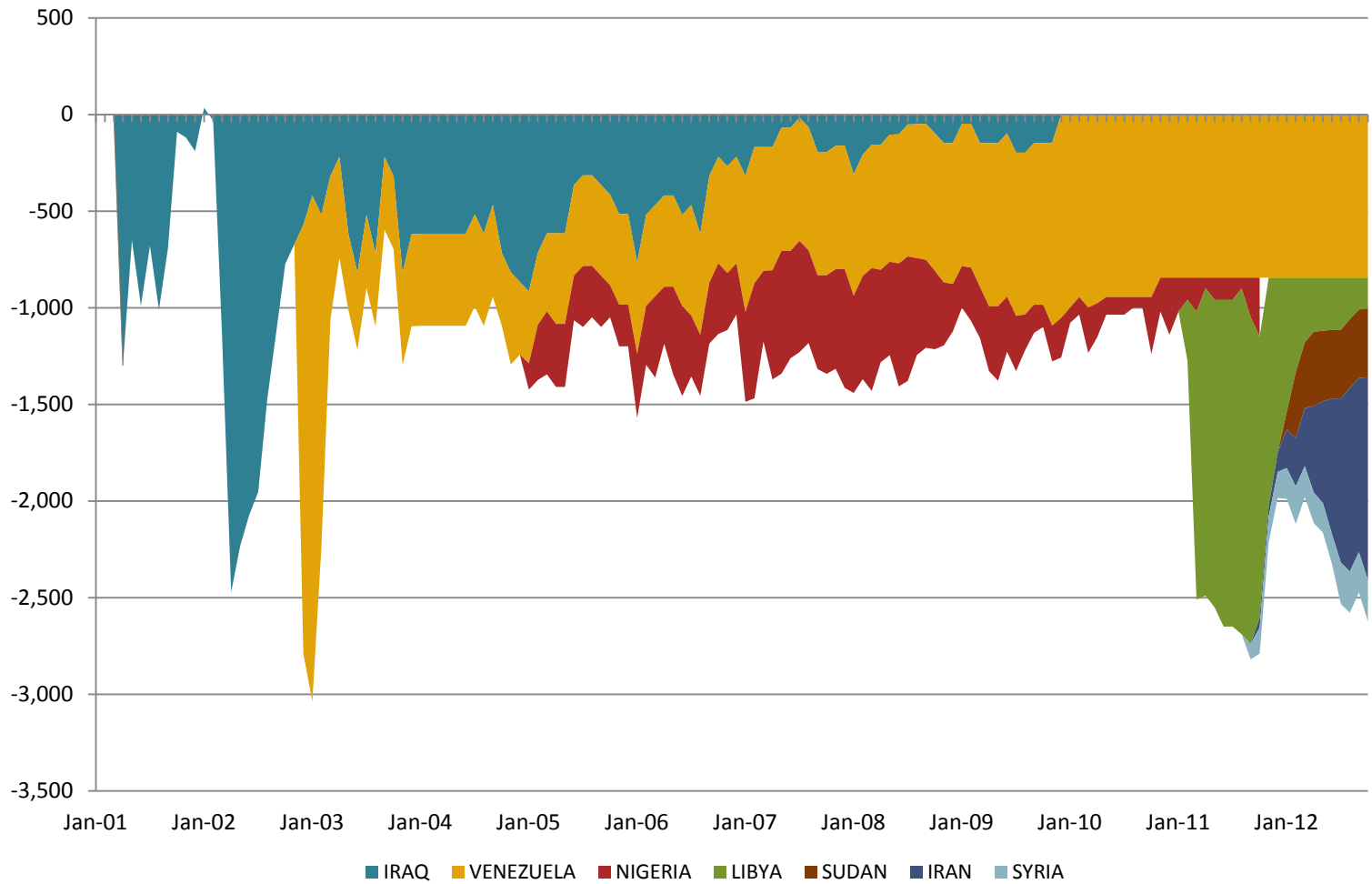


# DEMAND GROWTH DOESN'T DRIVE PRICES UP





# LOST SUPPLY



# REITERATE: MODELING PROBLEMS

- BIAS
- IGNORING PRICE, COST, FISCAL TERMS
- TECHNOLOGY
- RESERVE DATA
- **POLITICS**
- BEST RESEARCH TARGET:  
PRODUCTIVITY IMPROVEMENTS