

# **EXPLAINING RECOVERY GROWTH IMPLICATIONS FOR ASSESSMENT METHODOLOGY**

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# RECOVERY GROWTH

Why don't those @&%#\$! get it?

## Most Common Reactions

- (1) Never Heard of It – thinking dominated by the original 3-D model (Discovery, Development, and Depletion)
- (2) Denial – recovery growth is too inconvenient a truth



# COULD IT (GASP!) BE OUR FAULT?

- Reserve growth estimation is a methodology unhampered by theory
- Focused entirely on estimation, not explanation
- No model that the public can readily understand

# TOWARDS A BETTER EXPLANATION

- Emphasize historical context
  - Discovery history
  - Phases of reservoir development
  - Changing oil market
- Emphasize reservoir development economics and technology
- New explanations (theories) have methodological implications

# RECOGNIZING CONSTRAINTS

- **The key insight for explanation (K. King)**
- **Growth occurs because past development was constrained**
- **Two key constraints**
  - **Size of oil demand**
  - **Cost of development phases (supply curve)**

# THE IMPACT OF GIANT FIELDS

- Two bedrock facts of resource assessment
  - Concentration of oil in giant fields
  - Giant fields discovered early
- Implications for undiscovered assessments universally recognized
- Implications for reservoir development wholly ignored

# WHAT DOES RAPID INITIAL DEVELOPMENT OF GIANT FIELDS DO TO THE OIL MARKET?

- **Short answer – it is ruinous for oil producers**
- **Examples**
  - Los Angeles Basin, 1920-1923
  - East Texas field, 1930-1933
- **Production controls as a defensive and desperate response**



# PRODUCTION AND PRICE

<u>Crude Oil Production (million bbls)</u>					<u>Price</u>
	<u>ETXFld</u>	<u>PermB</u>	<u>U.S.</u>	<u>World</u>	(2006\$)
<u>1929</u>	0	135	1007	1486	13.30
<u>1930</u>	*	116	896	1412	12.63
<u>1931</u>	122	91	850	1374	7.05
<u>1932</u>	148	73	794	1311	11.15
<u>1933</u>	216	66	905	1441	8.16*

\* Low of \$3.29 (\$0.25 nominal) in June

# PRODUCTION CONTROLS AND DEVELOPMENT

- **Limit initial development**
  - Ghawar
- **Delay initial development**
  - Shaybah
- **Delay and limit subsequent phases of development**
  - Saudi Aramco's investment strategy

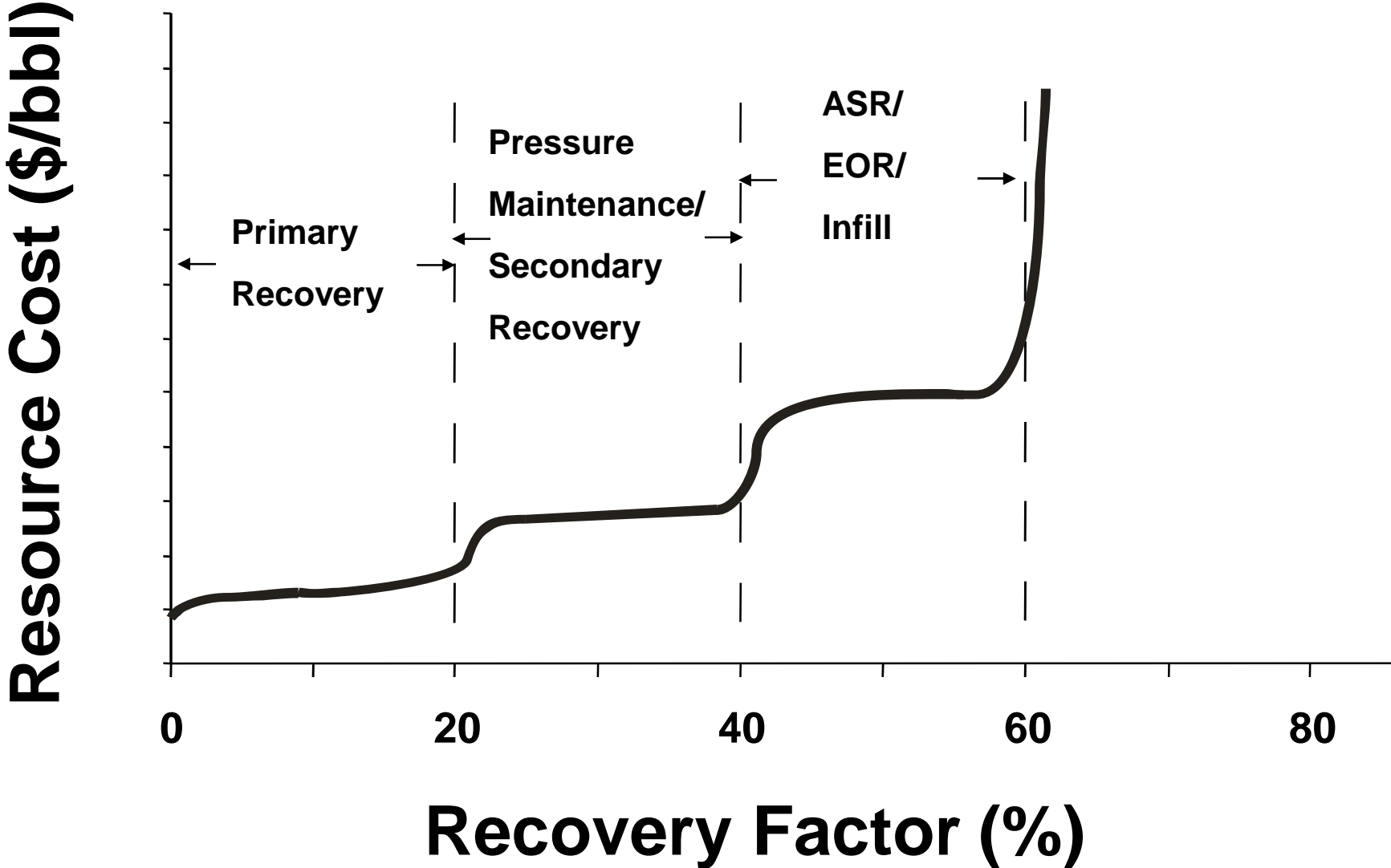
# PRODUCTION CONTROLS AND GROWTH POTENTIAL

- **Two different situations**
- **Where controls are present, growth opportunities are substantial because of limited past development**
- **Where controls are not present, past development was only constrained by cost and technology**

# THE COST CONSTRAINT AND RECOVERY GROWTH

- Every oil reservoir has a supply curve
- Relates recovery factor to cost
- A stair-step function
- Steps equal phases of development (SPE projects)
- Steps correspond to discontinuities in effort and returns to effort

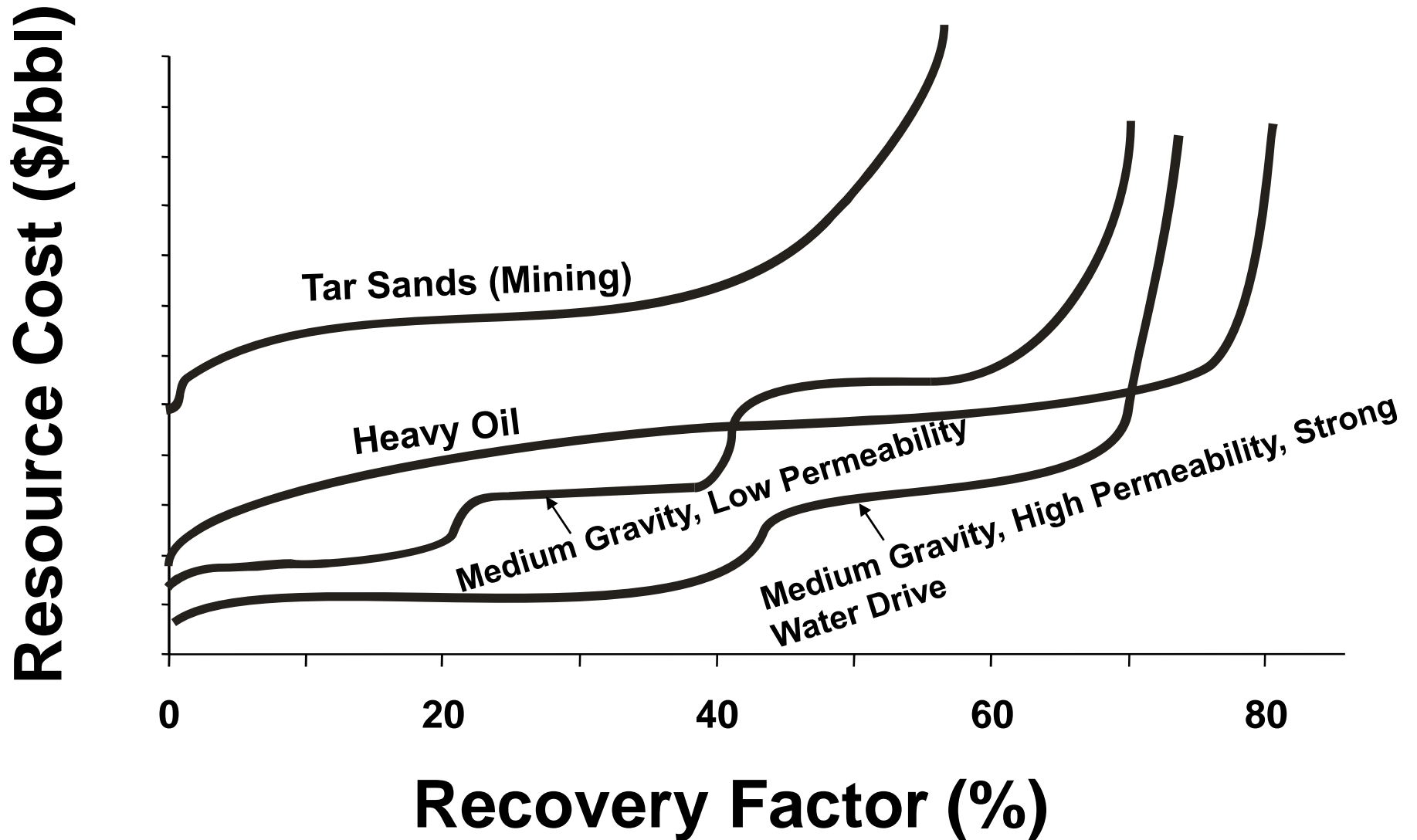
# THE RESERVOIR SUPPLY CURVE



# THE DISTRIBUTION OF SUPPLY CURVES

- **The supply curve shape varies among reservoirs**
- **Variations in reservoir quality create the various supply curves**
  - **Rock quality (permeability, heterogeneity)**
  - **Fluid quality (viscosity/density)**
  - **Location (easy vs. difficult)**

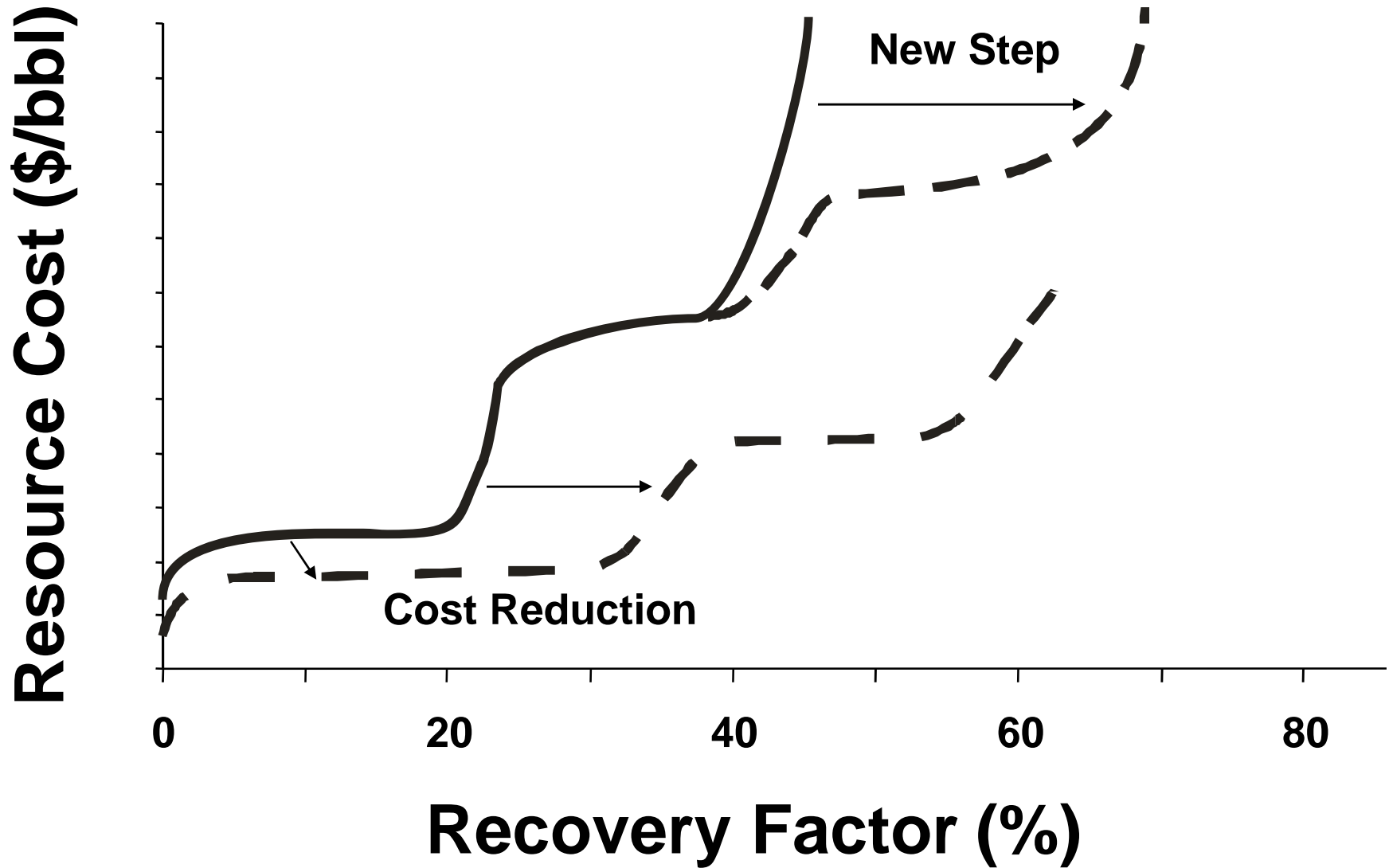
# SUPPLY CURVE VARIABILITY



# THE DYNAMIC SUPPLY CURVE

- **Supply curves change over time**
- **Changes driven by improving technology and knowledge**
- **Two types of changes**
  - **Creating new steps (increasing ultimate recovery factor)**
  - **Lowering and lengthening existing steps (reducing costs and increasing ultimate recovery factor)**

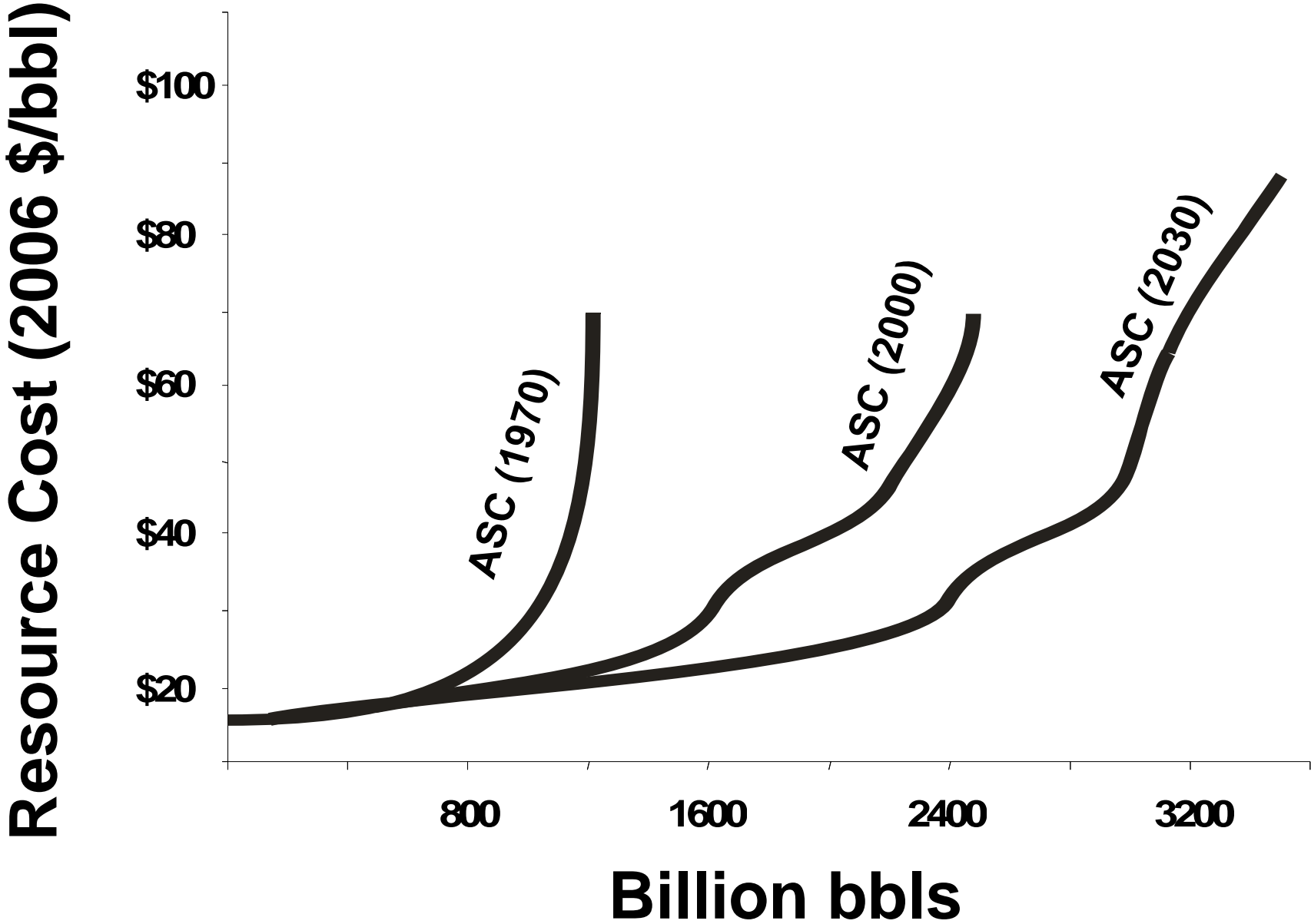
# TECHNOLOGY CHANGE AND THE SUPPLY CURVE



# THE AGGREGATE SUPPLY CURVE

- The reservoir supply curves can be aggregated
- The ASC relates quantity to cost
- The ASC is also dynamic

# THE AGGREGATE SUPPLY CURVE



# THE SUPPLY CURVE AND THE OIL MARKET

- **Price stability along steps**
- **Price increases approaching risers**
- **Price can decrease as curve shifts**
- **Most policy (taxes and development restrictions) increase prices**

# METHODOLOGICAL IMPLICATIONS

- **Methods need theory – explanation must accompany estimation**
- **To be credible, explanation must be tied to observable reality**
- **The relevant realities for recovery growth are reservoir properties, development history, technology, and economics**

# **METHODOLOGY IMPLICATIONS (2)**

**Growth factor approach has dominated**

- **Appropriate for demand-constrained market**
- **Questionable for supply-constrained market**
- **Explains poorly – too abstract**

# METHODOLOGICAL IMPLICATIONS (3)

**Emerging approach: Reservoir  
characterization & engineering,  
development history & economics**

- **Appropriate for supply-constrained  
market**
- **Empirically rich – more credible  
explanations**

# THE EMERGING APPROACH

Conducted at many levels of analysis

- Individual fields (Tennyson)
- Plays (Nehring)
- Play groups (-----)
- Large aggregations (King)

All have similar data needs



# NEEDED IMPROVEMENTS

- **Integrating levels of analysis**
- **Technical recovery limits**
- **Economic recovery limits**
- **More relevant reservoir groups**
- **Establishing reference examples**

# RECOVERY GROWTH AND THE SUPPLY CURVE

## Two different starting points

### (1) From proved developed recovery

- Demand growth and relaxation of production restrictions

### (2) From proved developed and undeveloped recovery

- Price increases
- Technological change