An Assessment of Marginal Production in the Gulf of Mexico and Lost Production from Early Decommissioning

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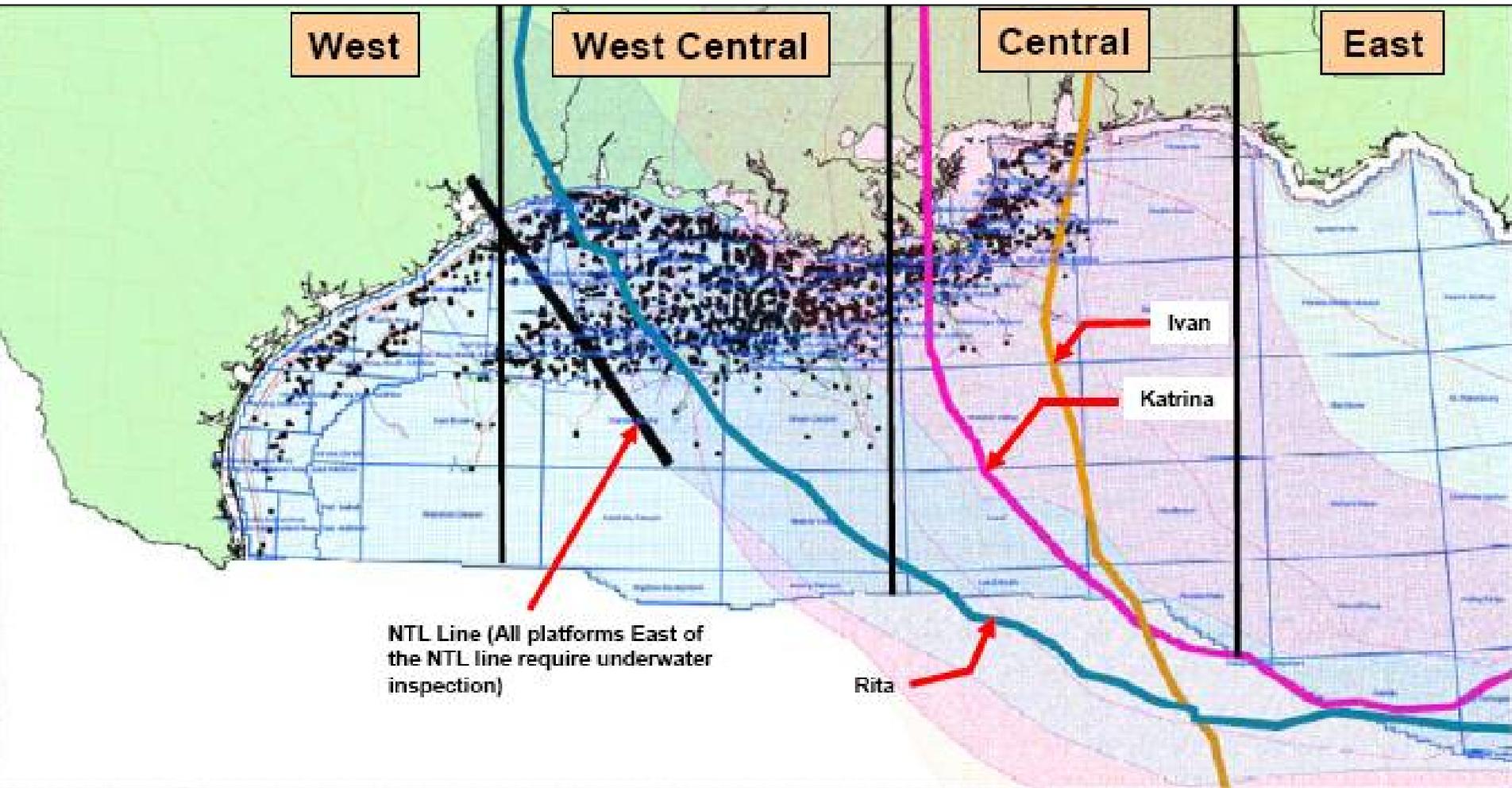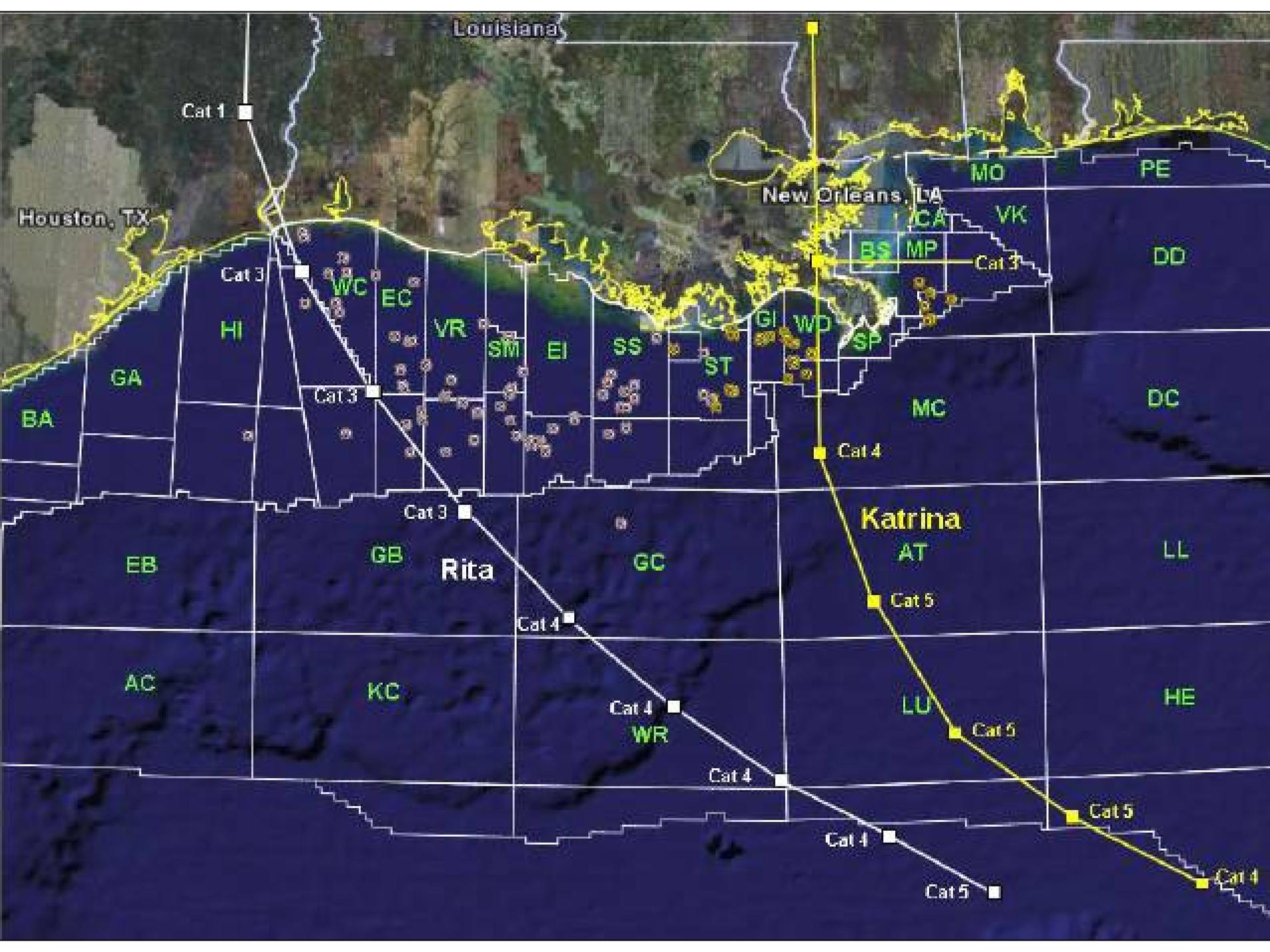**MMS Information Technology Meeting**
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PART 1

Lost Production from Hurricanes Ivan, Katrina, and Rita

Task: Estimate the quantity and value of production "lost" from structures destroyed by Ivan, Katrina, and Ivan

West

West Central

Central

East

Ivan

Katrina

Rita

NTL Line (All platforms East of the NTL line require underwater inspection)

MP 307 'A'
Tripod in 79' Water Depth
Installed in 1985
33' Bottom Deck Height

VK 29 'A'
Braced Caisson in 113' Water Depth
Installed in 1988
32' Bottom Deck Height

MP 293 SORAT
4-Pile in 232' Water Depth
Installed in 1972
42' Bottom Deck Height

MP 296 'A'
8-Pile in 212' Water Depth
Installed in 1970

MP 279 'D'
4-Pile in 290' Water Depth
Installed in 1990

MP 252 'A'
8-Pile in 257' Water Depth
Installed in 1969
43' Bottom Deck Height

MP 277 'A'
4-Pile in 223' Water Depth
Installed in 2000

MP 252 C
8-Pile in 244' Water Depth
Installed in 1969
40' Bottom Deck Height

MC 20 K
8-Pile in Mudslide Area
475' Water Depth
Installed in 1996

MP 338 'B'
8-Pile in 257' Water Depth
Installed in 1969
40' Bottom Deck Height

Mobile

Chandeleur Area

Chandeleur Area, East Addition

Viosca Knoll

Breton Sound Area

Main Pass Area

Main Pass Area, South and East Addition

South Pass Area, South and East Addition

West Delta Area

South Pass Area, South and East Addition

Delta Area, South Addition

HORN MOUNTAIN
THUNDER HORSE

PETRONIUS

MARS

NEPTUNE

VIRGO

BRUTUS

CRAZY HORSE

RAM POWELL

Louisiana

Houston, TX

New Orleans, LA

Cat 1

Cat 3

MO

PE

CA

VK

BS

MP

DD

Cat 3

WC

EC

HI

VR

SM

EI

SS

GI

WD

SP

GA

ST

Cat 3

BA

MC

DC

Cat 3

Cat 4

GB

Rita

GC

Katrina

AT

LL

EB

Cat 5

Cat 4

AC

KC

LU

HE

Cat 4

WR

Cat 5

Cat 4

Cat 5

Cat 4

Cat 5

Typhoon Field

$250 Million; 4 wells; 40,000 bopd, 60 MMcfpd, 2,100 ft WD

Damage Assessment

Impact Summary

	Ivan/Katrina/Rita	Ike/Gustav
Number Exposed	3,522	2,127
Number Destroyed (%)	126 (3.5%)	60 (3%)
Number Damaged (%)	183 (5.8%)	124 (5.2%)
Rigs Destroyed	9	4
Rigs Extensively Damaged	23	

Typically, **2-5%** of structures exposed to hurricane force winds will be **destroyed** and **3-7%** will be **damaged**

More Generalizations

- **Probability of failure** is primarily based on **deck elevation** and **platform strength,** which are dependent on **vintage, design codes, and operator preference in construction**

- **Platforms designed to higher standards have smaller failure rates**
  - API RP2A Section 2, Section 17
  - Exposure Categories:
    - L1, A1 (High consequence of failure; e.g., manned platforms)
    - L2, A2
    - L3, A3 (Low consequence of failure; e.g., caissons)

- **No correlation between eye path and distance to destroyed platform**

Redevelopment Decision Making

Factors Involved in Decision Making

- Production level
- Remaining reserves
- Anticipated future oil and gas price
- Drilling opportunities
- Strategic reasons
- Economic thresholds

Economic Criteria

- In theory, a destroyed structure will not be redeveloped if

  COST(Cleanup+ Redevelopment) > **VALUE(Future Production)**

- In practice, we don't have the cost information, and so **our model is not predictive**

- It is easy to **observe** if a lease is redeveloped by reviewing production history at a later time

Data Source

MMS Final Official List

- Following a major hurricane, the MMS issues NTLs that require platform owners to perform above- and below-water inspections of infrastructure exposed to hurricane force winds (**Level Surveys**)

- MMS releases a "final" official assessment of damaged and destroyed platforms

- **The official list of destroyed platforms was used in this study to fix the sample set at the time of analysis (circa 2006)**

Errors on Both Sides

- Assume **all destroyed** structures will **not** be **redeveloped**
  - **Overestimate (but can be checked)**
- Assume final list is **complete** and **no damaged** structure will later be **reclassified** as destroyed or **other structures will be decommissioned** as a result of the hurricanes
  - **Underestimate (cannot easily be checked)**
  - **Believed to be significant, but value uncertain**
  - **In Katrina and Rita, reported that 150–200 additional structures have been or will be decommissioned because of the storms**

Model Description

Scenario Analysis

- Consider each destroyed structure
- Model production profile and classify
  - Young, Normal, Chaotic, Uneconomic, Unknown
- Estimate future production and discounted revenue under different price scenarios, economic limit thresholds, and discount rate
- Terminate production when economic limit of structure is reached
- Aggregate and report

Methodology
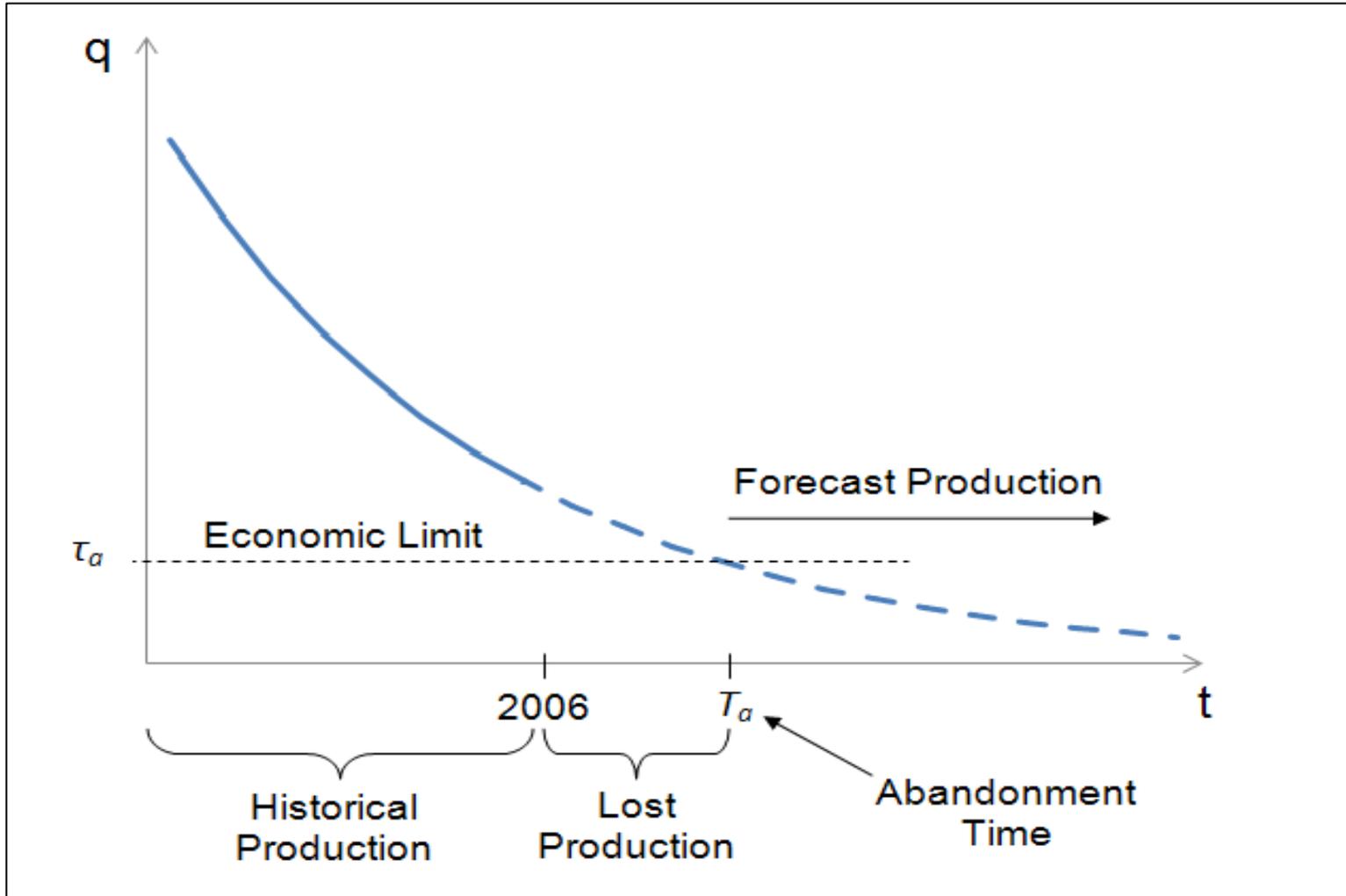
Production Classification

- **Idle (22)**
  - Structures that have not produced for > 1 yr
- **Auxiliary (8)**
  - Structures that have never produced
- **Uneconomic (21)**
  - Initial production falls below economic limit
- **Young (19)**
  - Production life < 7 years
- **Normal (39)**
  - Best-fit model R^2 > 0.75
- **Chaotic (9)**
  - Decline curve analysis not applicable; assume exponential decline
- **Unknown (5)**
  - Missing and/or incomplete identification

Model Class: Normal; Structure 152
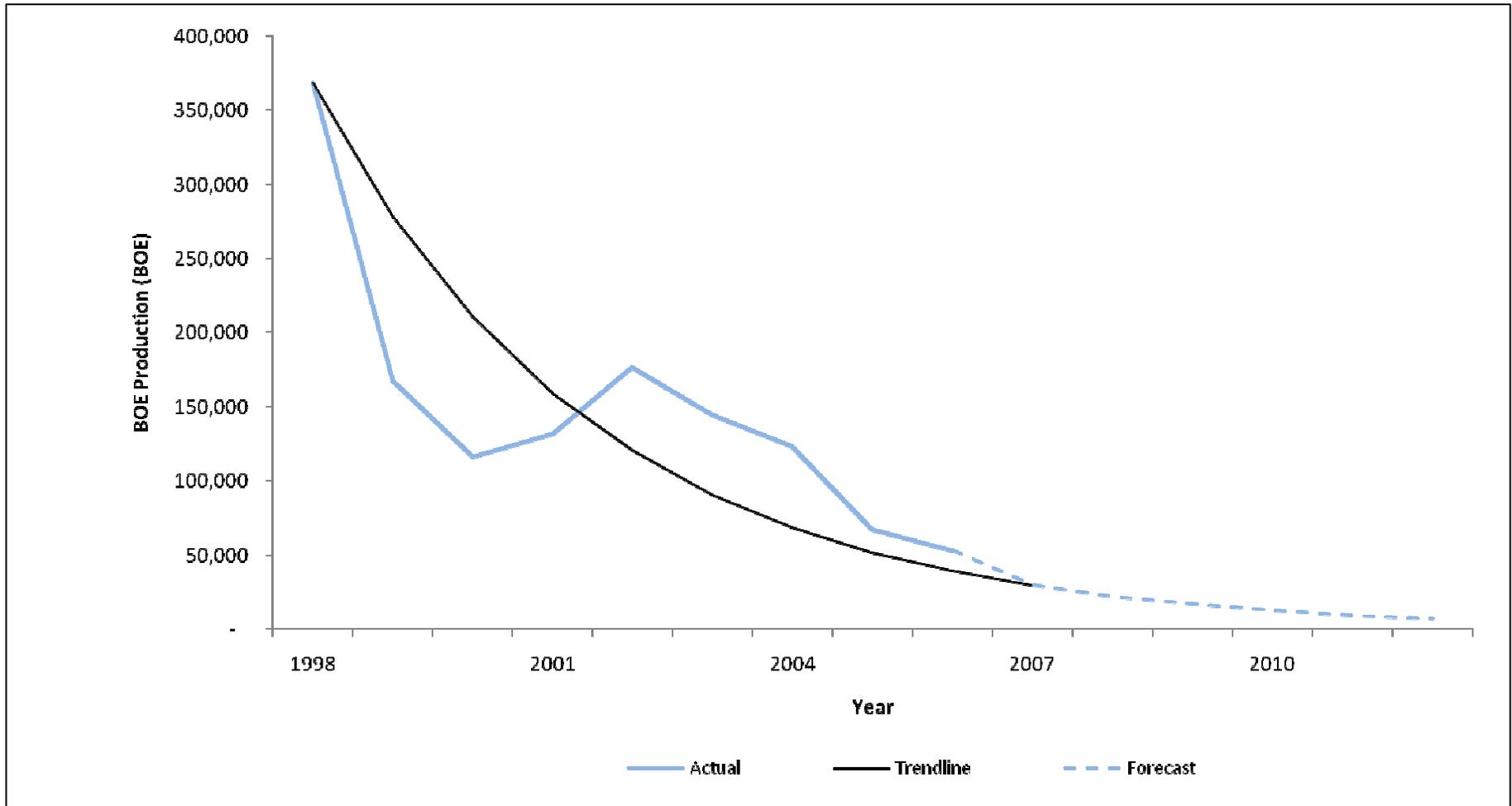
Model Class: Chaotic; Structure 23266
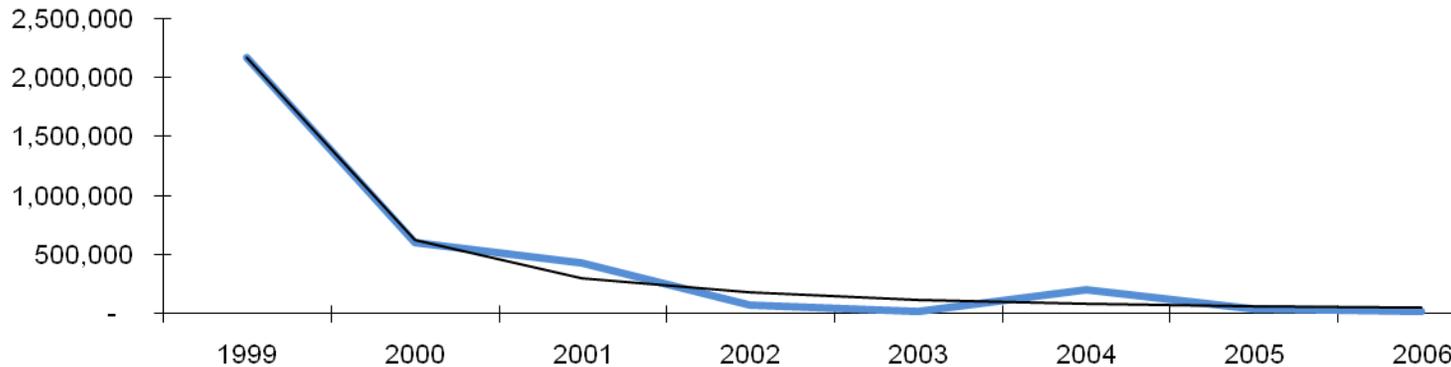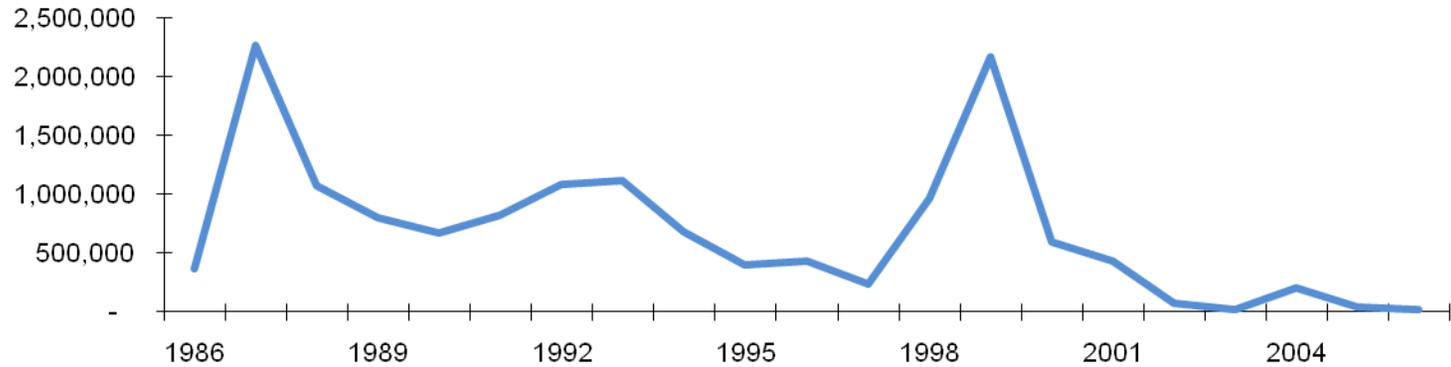
Model Results

Cumulative Oil Production – Economic Limit Multiplier (K), Price Scenario
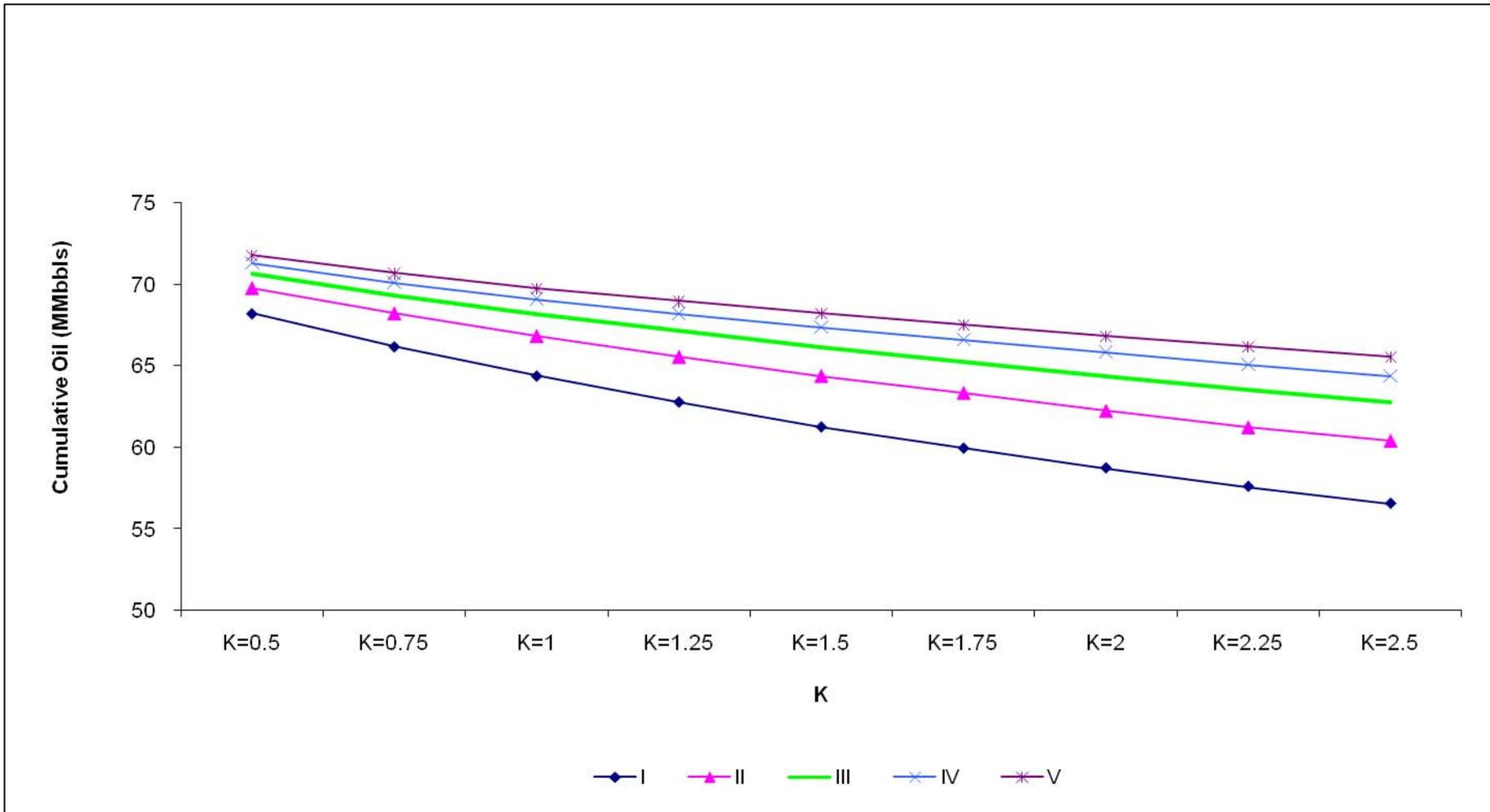
Cumulative Gas Production –
Economic Limit Multiplier (K), Price Scenario
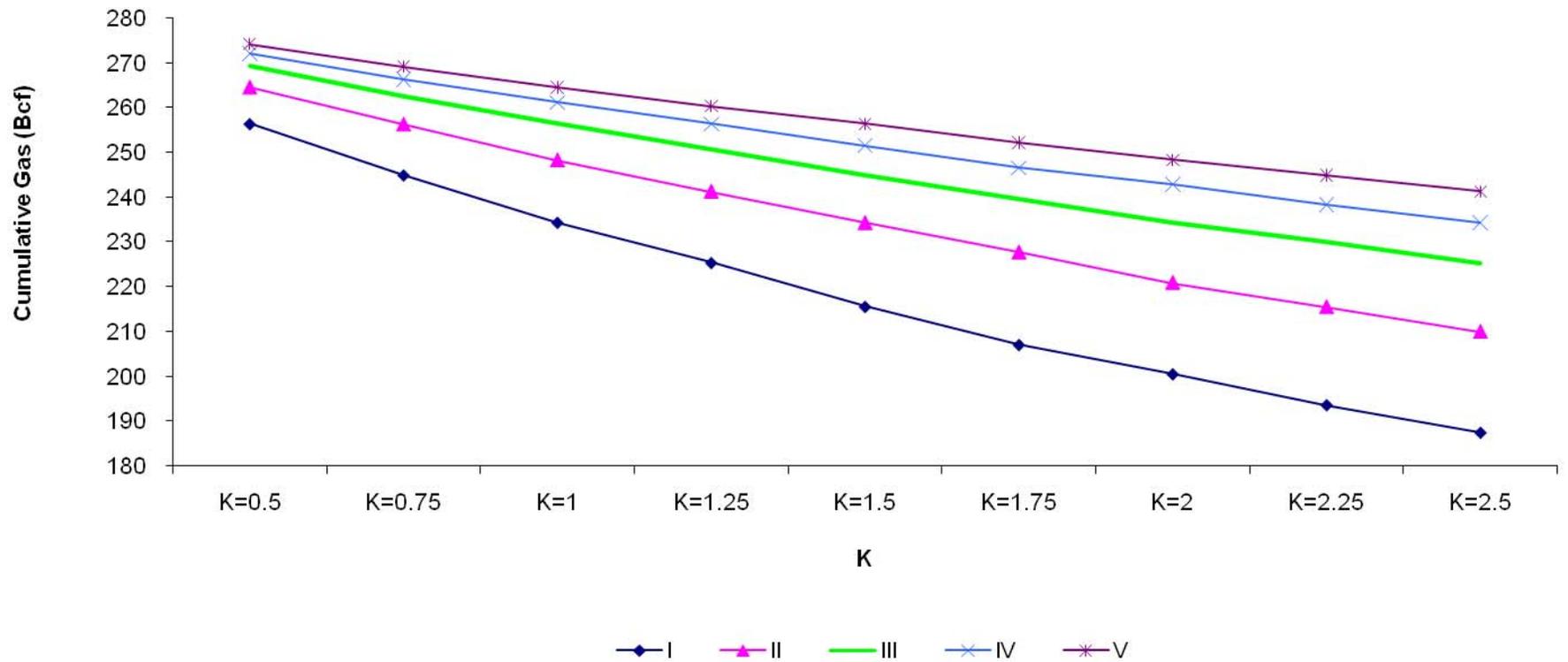
Present Value – Price Deck P(I), Discount Rate D, Threshold Level K
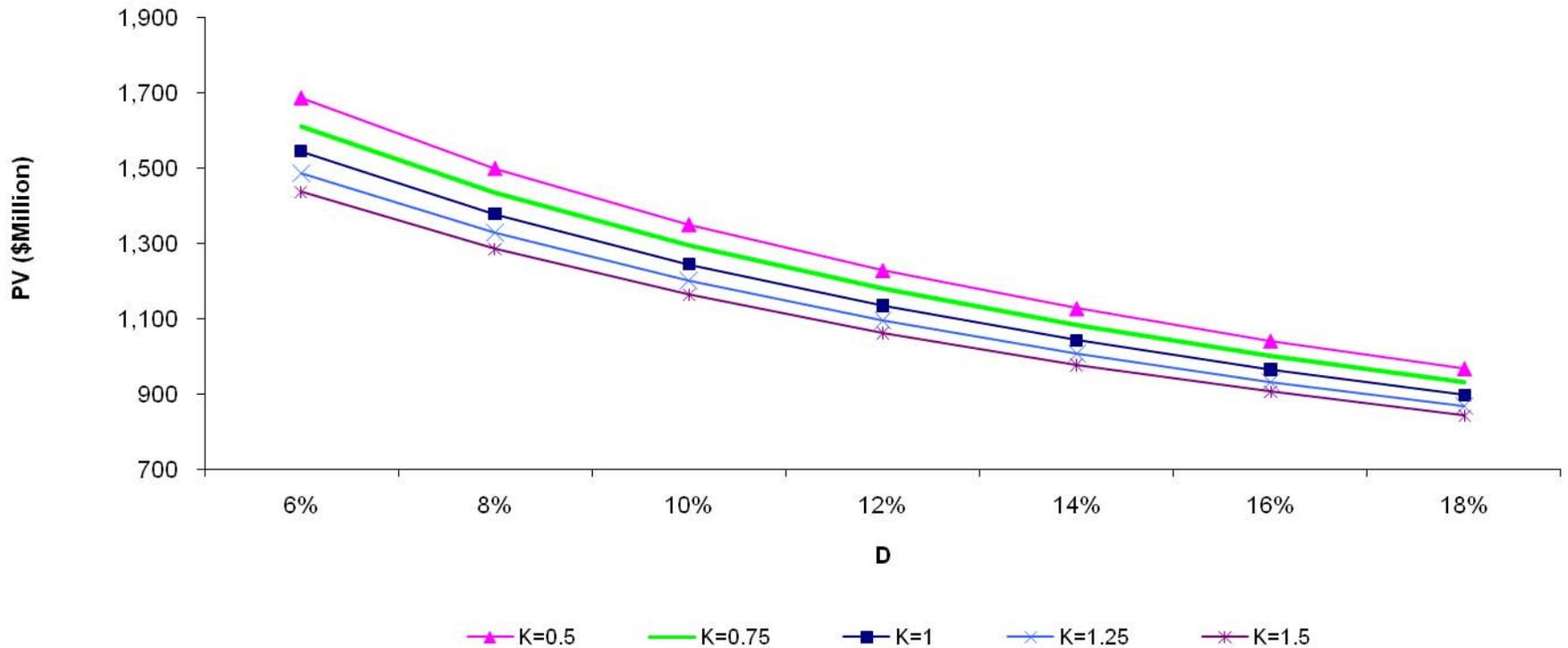
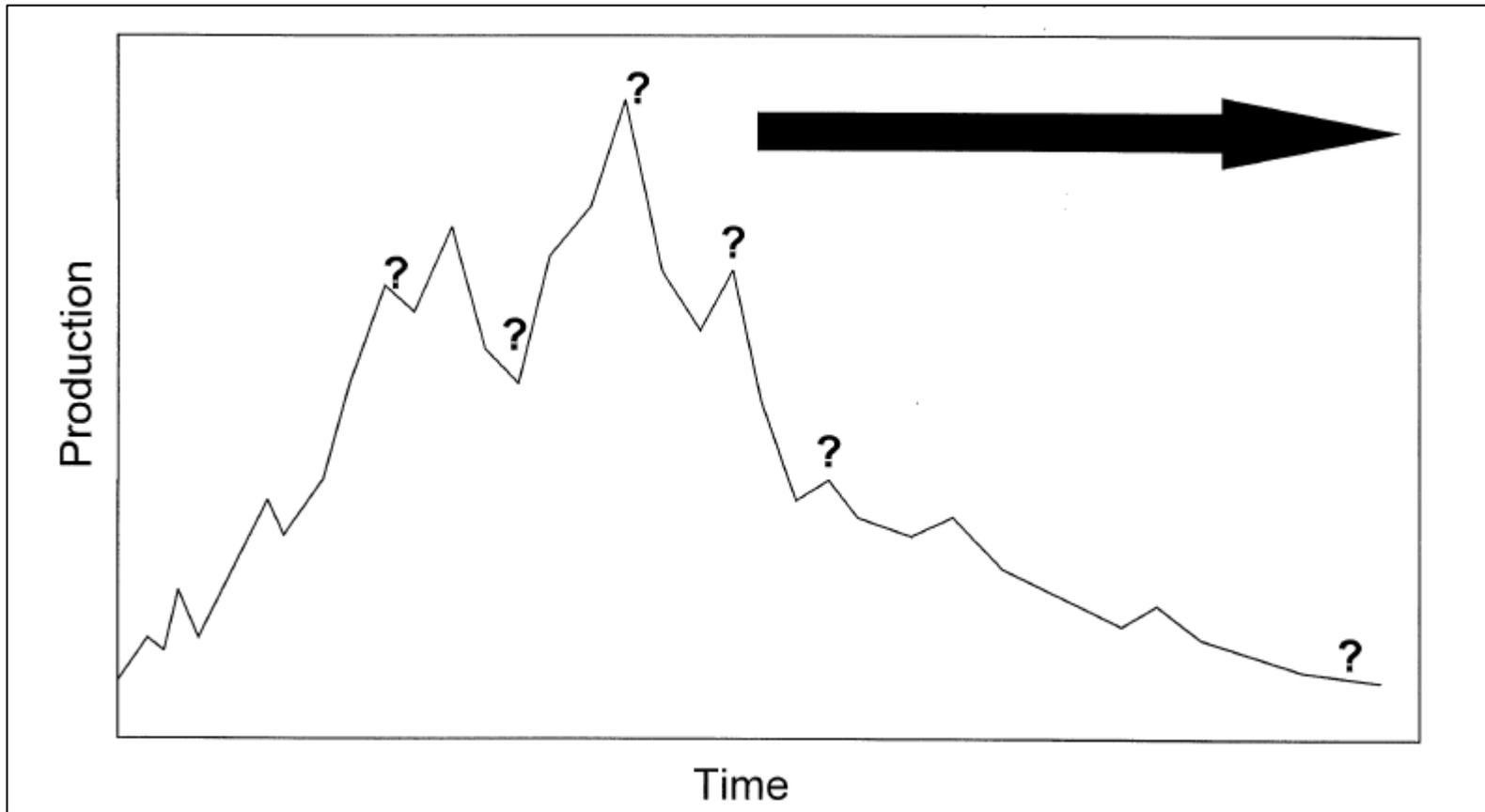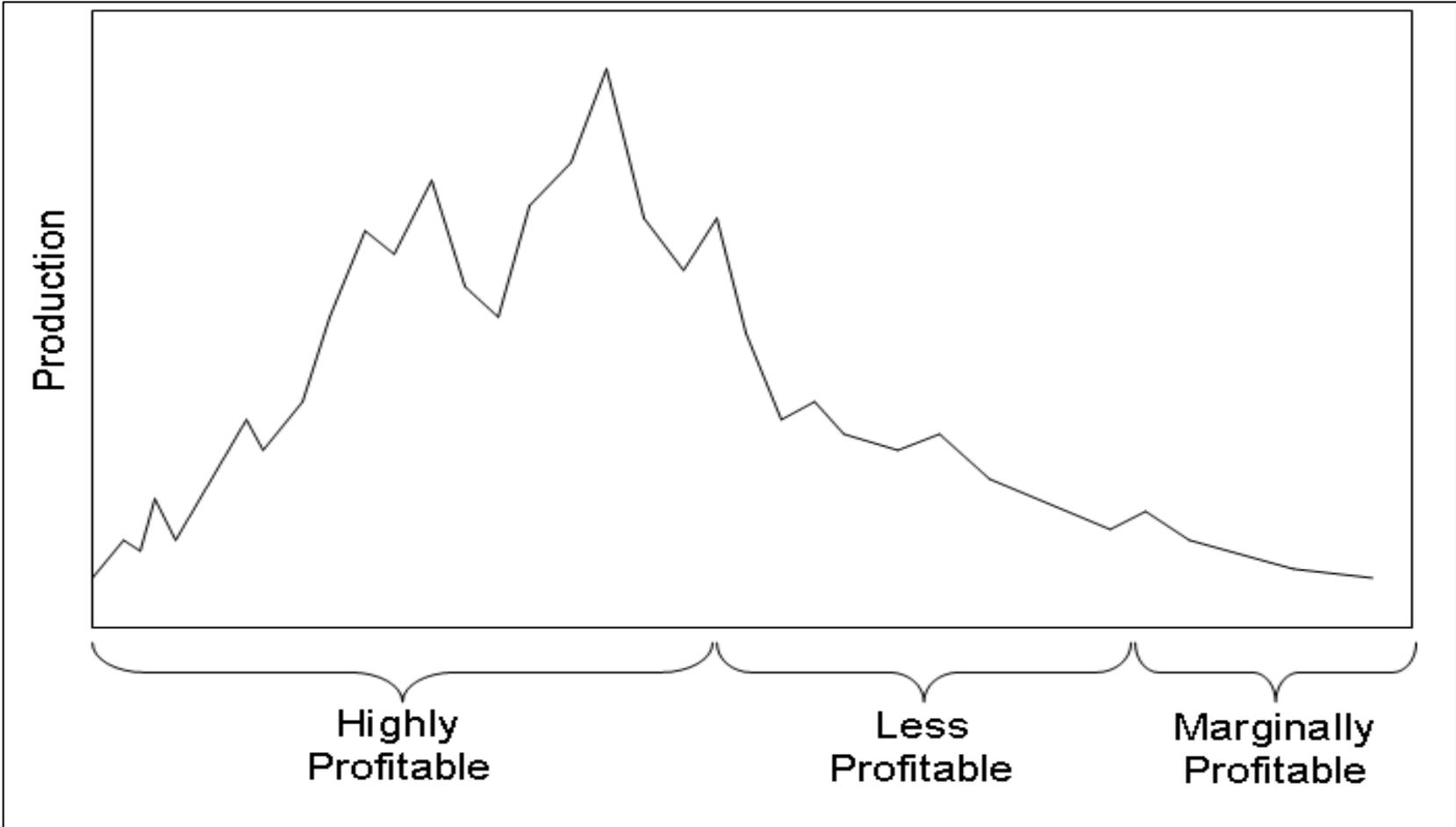# Present Value – Price Deck P(III), Discount Rate D, Threshold Level K
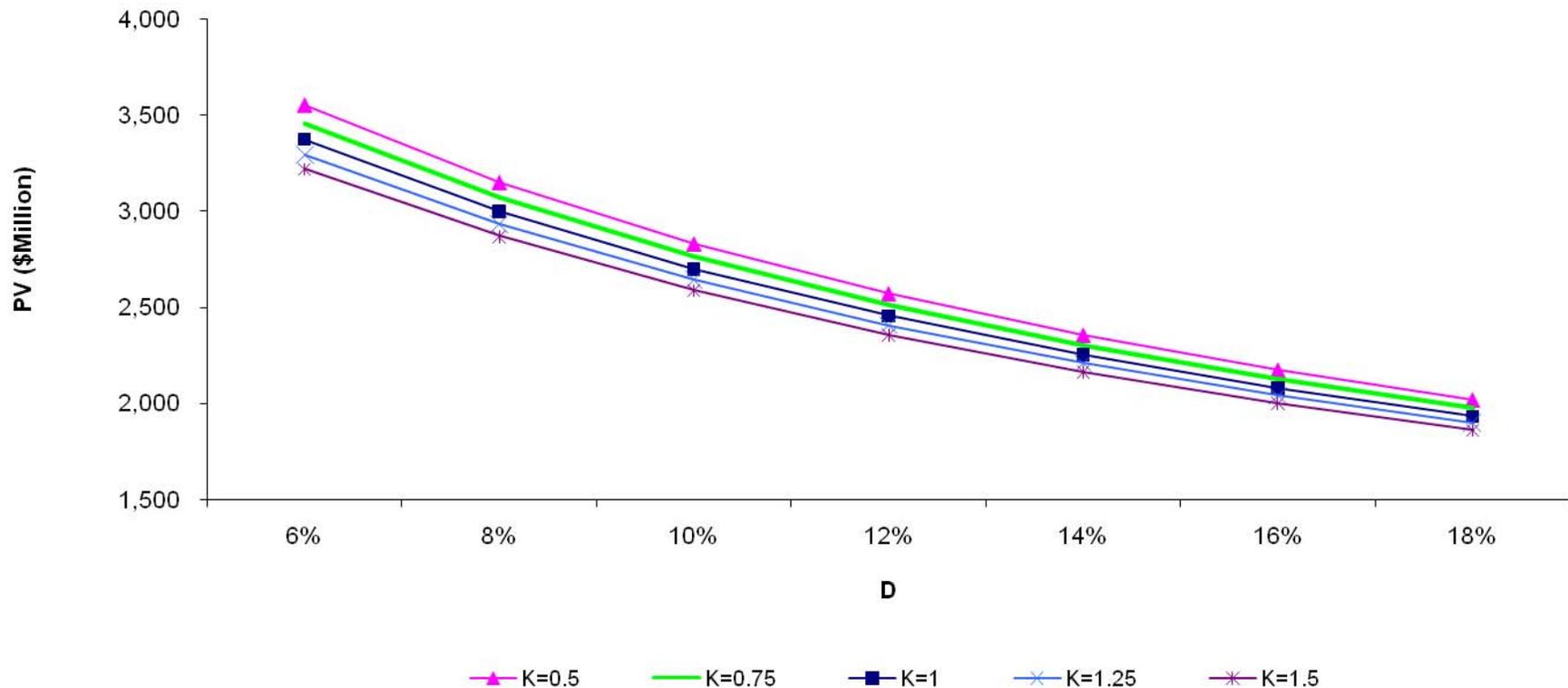
PART 2

Forecasting Marginal Production in the Gulf of Mexico

Task: Estimate the number of marginal structures, quantity and value of marginal production

When Does a Field Become Marginal?

# No General Definition Exists, but Common Characteristics Include

- Smaller production levels (e.g., 50–100 BOEPD)
- Decreasing pressure
- Increasing water production
- More operational problems
- Increasing operating cost
- Riskier production (from fewer wells)

- **Generally, cost of operations increases while the revenue from production (normally) decreases**

Marginal Status (Definition)

- Compare revenue of structure **s** at time **t**, **REVENUE(s,t),** against various threshold levels referenced against the **ECONOMIC_LIMIT(s)**

- **Economic/Commercial:**
  - **REVENUE(s,t)** > **Marginal_Threshold(s)**

- **Marginal:**
  - **Abandonment _Threshold(s)** < **REVENUE(s,t)** < **Marginal_Threshold(s)**

- **Uneconomic/Abandon:**
  - **REVENUE(s,t) <** **Abandonment_Threshold(s)**

Methodology
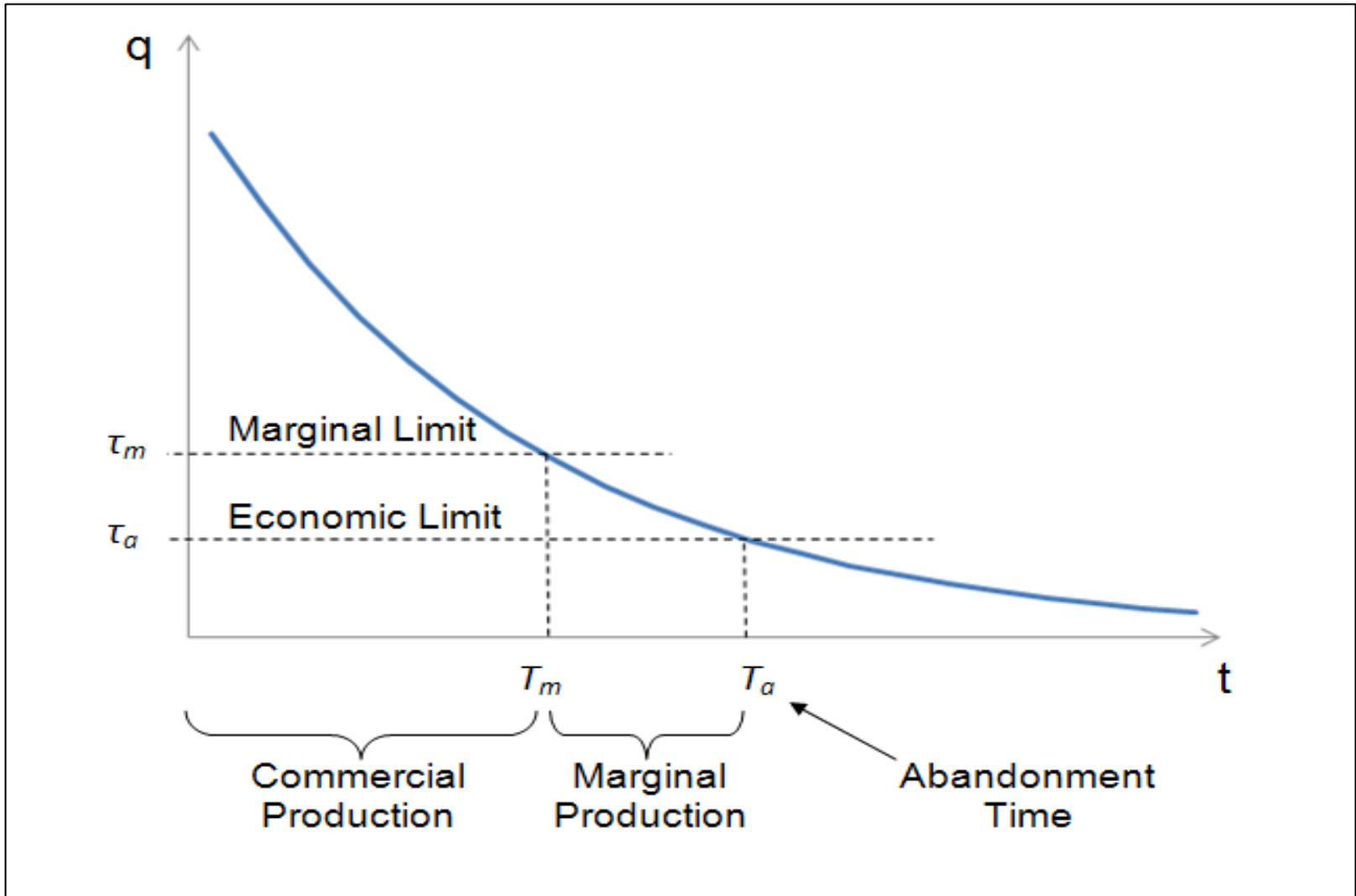
Marginal Threshold = Artificial Construct

- **Economic limits** vary with structure type, production type, operator, and lease status, but are **well-defined and reasonably consistent across industry**

- **Marginal thresholds** are **not commonly** used in industry **nor do they represent a specific operational milestone**

- **Marginal thresholds** are an **artificial construct** required to identify marginal producers

- **Marginal and economic thresholds** can be used as an **indicator of future removal trends**

Data Source

Committed Asset Inventory Circa 2006

- All producing structures in the GOM as of June 2006
  - 2,398 producing assets out of 3,830 total
- Shallow-water structures (< 1,000 ft)
  - 2,364 producing assets

Table 1. Active structures in the shallow water Gulf of Mexico classified by primary production and structure type in 2006

Production Type[a]	Caisson	Fixed Platform	Well Protector	Unknown	Total
Gas	458	1093	157	27	1735
Oil	126	416	72	15	629
All	584	1509	229	42	2364

Footnote:(a) Structures are classified as oil or gas producers according to their cumulative gas-oil ratio (GOR) measured in cf/bbl. Structures with GOR $\leq$ 5,000 are primarily oil producers; structures with GOR > 5,000 are primarily gas producers.

Categorization

- Create reasonably **homogenous categories** to facilitate **process-oriented, automated approach** to forecasting
- Structures categorized by:
  - Structure Type (Caisson, Well Protector, Fixed Platform)
  - Primary Production (Oil, Gas)
  - Production Profile (Young, Normal, Chaotic, Latecomer, Unknown)
- Production class categories are used to **manage model uncertainty**

Table 2. Active structures in the shallow water Gulf of Mexico classified by production class and production type in 2006

Production Class[a]	Production Type		Total
	Gas	Oil	
Young	462	63	525
Normal	854	426	1280
Chaotic	64	26	90
Latecomer	378	49	427
Unknown	27	15	42
Total	1735	629	2364

Footnote: (a). Young structures have less than 7 years production and are forecast using history matching. Normal structures have best-fit decline curves with $R^2 \geq 0.75$, and chaotic structures have best-fit decline curves with $0.50 < R^2 < 0.75$. Normal and chaotic structures are forecast with regression techniques. Latecomer structures exhibit unusual profiles that do not conform to standard curve fitting techniques. Latecomer structures are forecast with heuristic methods. Unknown structures have missing identification and are forecast with one of the described methods.

Model Description

Model Assumptions

- Inventory of shallow-water producing structures is **fixed circa 2006**

- **Projects in development or planned in the future are not considered**

- **Reasonable bounds on user beliefs about future scenarios assumed**

Design Space
(Reasonable Bounds On User Beliefs)

Table 3. Model parameters and distribution functions

Parameter	Notation (Unit)	Distribution[a]
Decline rate	d (%)	U(5, 30)
Oil price	P^o ($/bbl)	N(120, 20)
Gas price	P^g ($/Mcf)	N(12, 2)
Marginal threshold multiplier	m	U(a,6)
Economic limit multiplier	a	U(0.5, 3)
Discount rate	D (%)	U(8, 14)

Footnote: (a) U(a, b) denotes the Uniform distribution with endpoint (a, b). N(μ, σ^2) represents the Normal distribution with mean μ and variance σ^2.
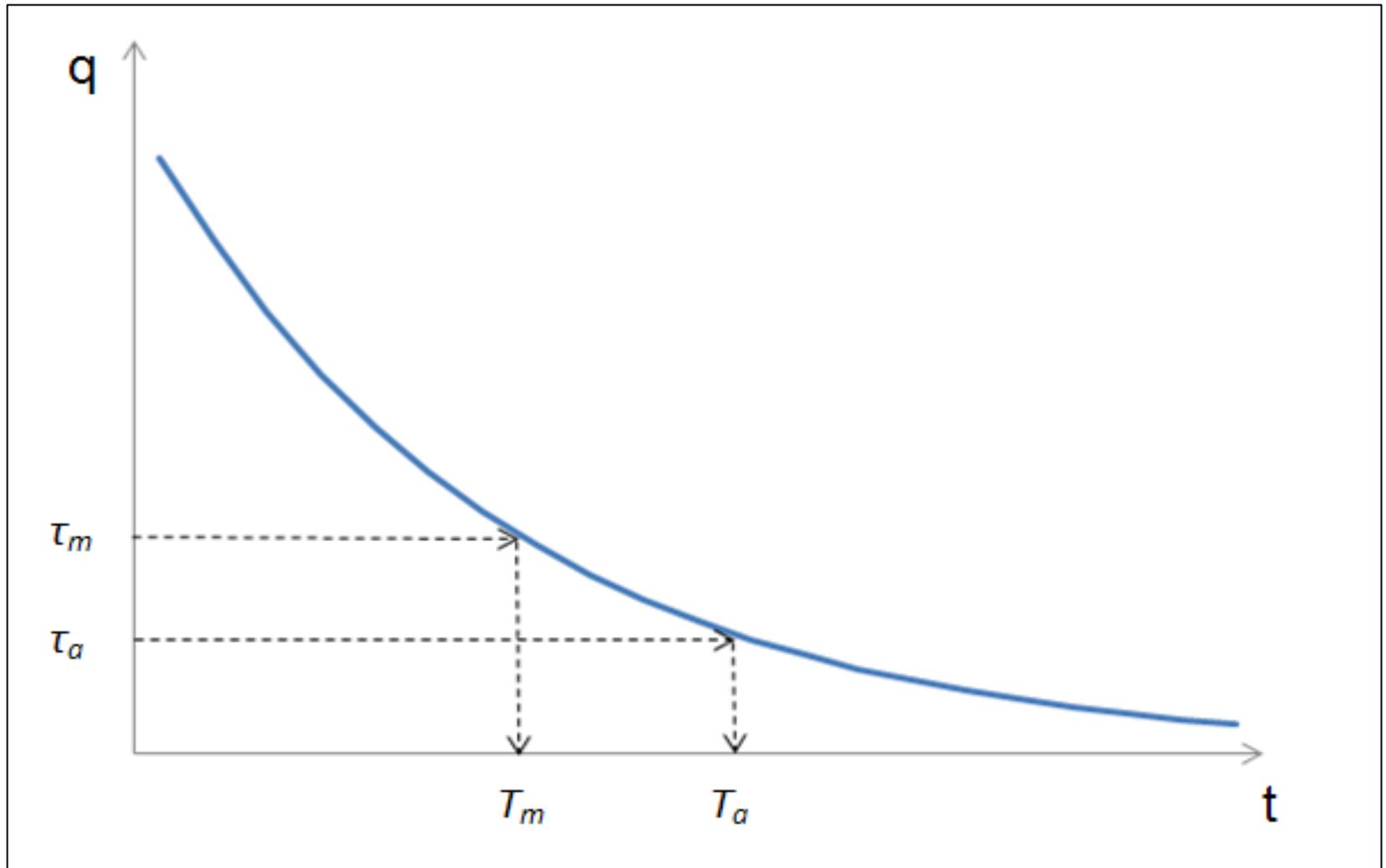
Methodology

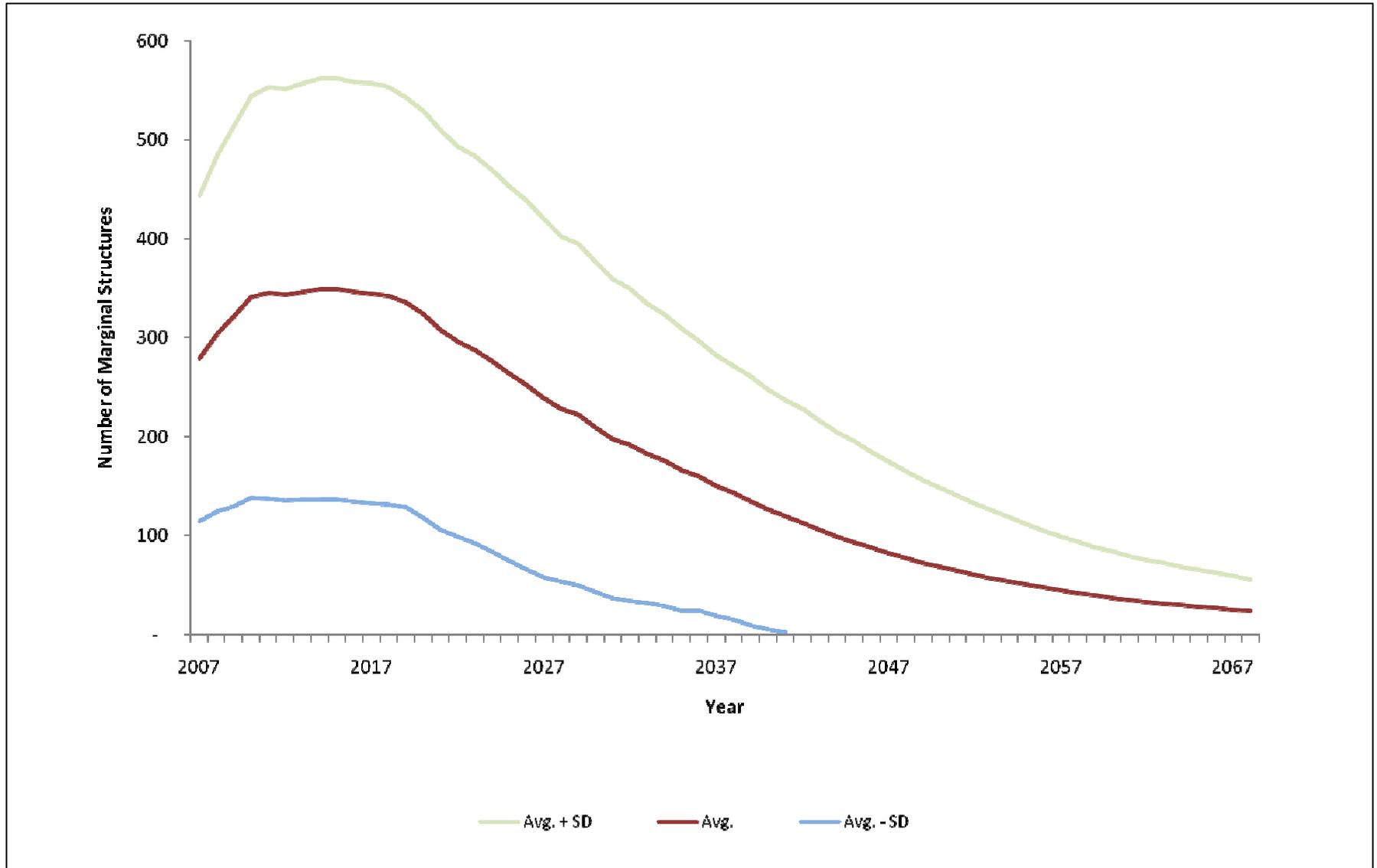# Methodology
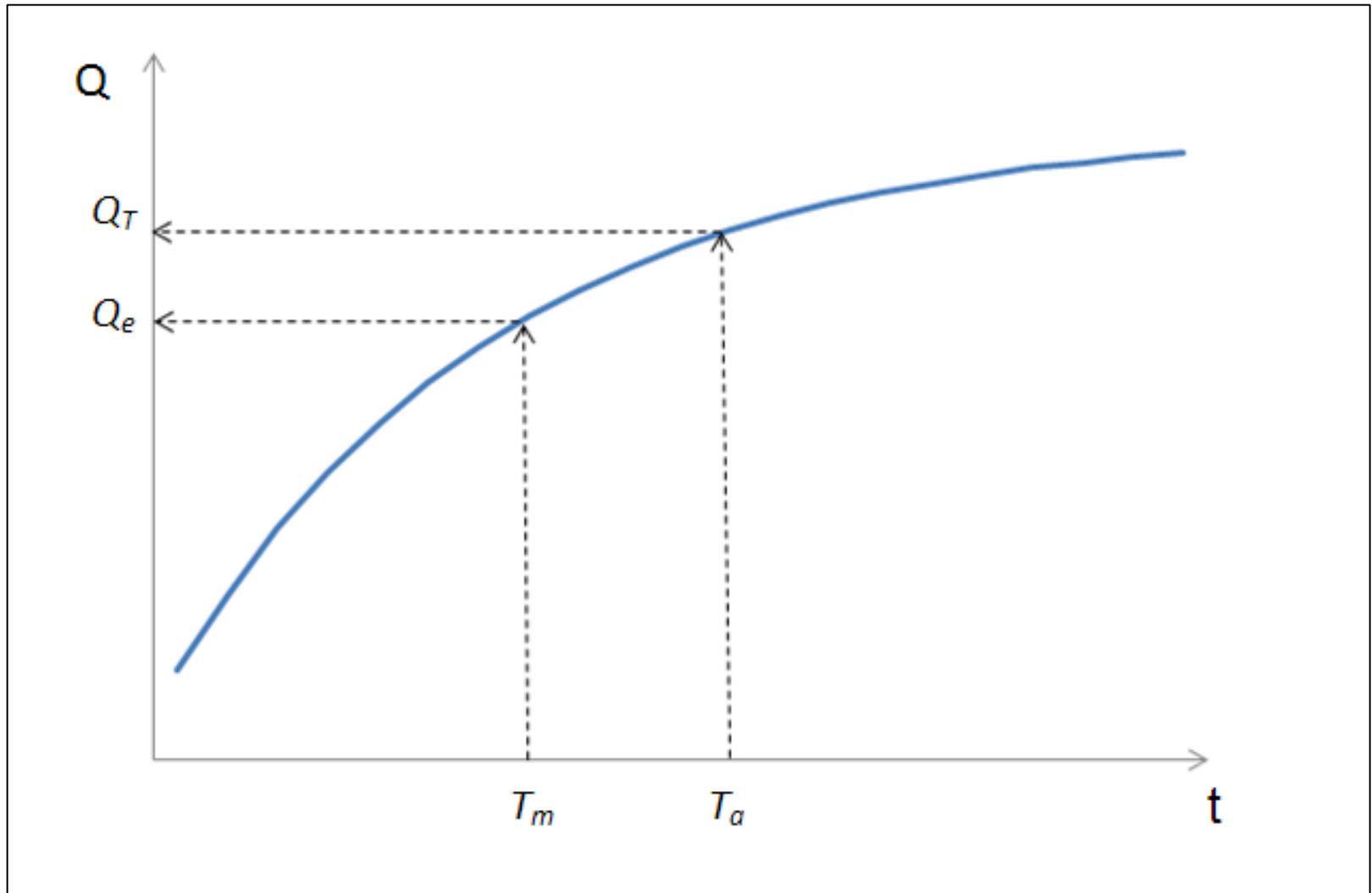
Model Results

Number of Committed Assets
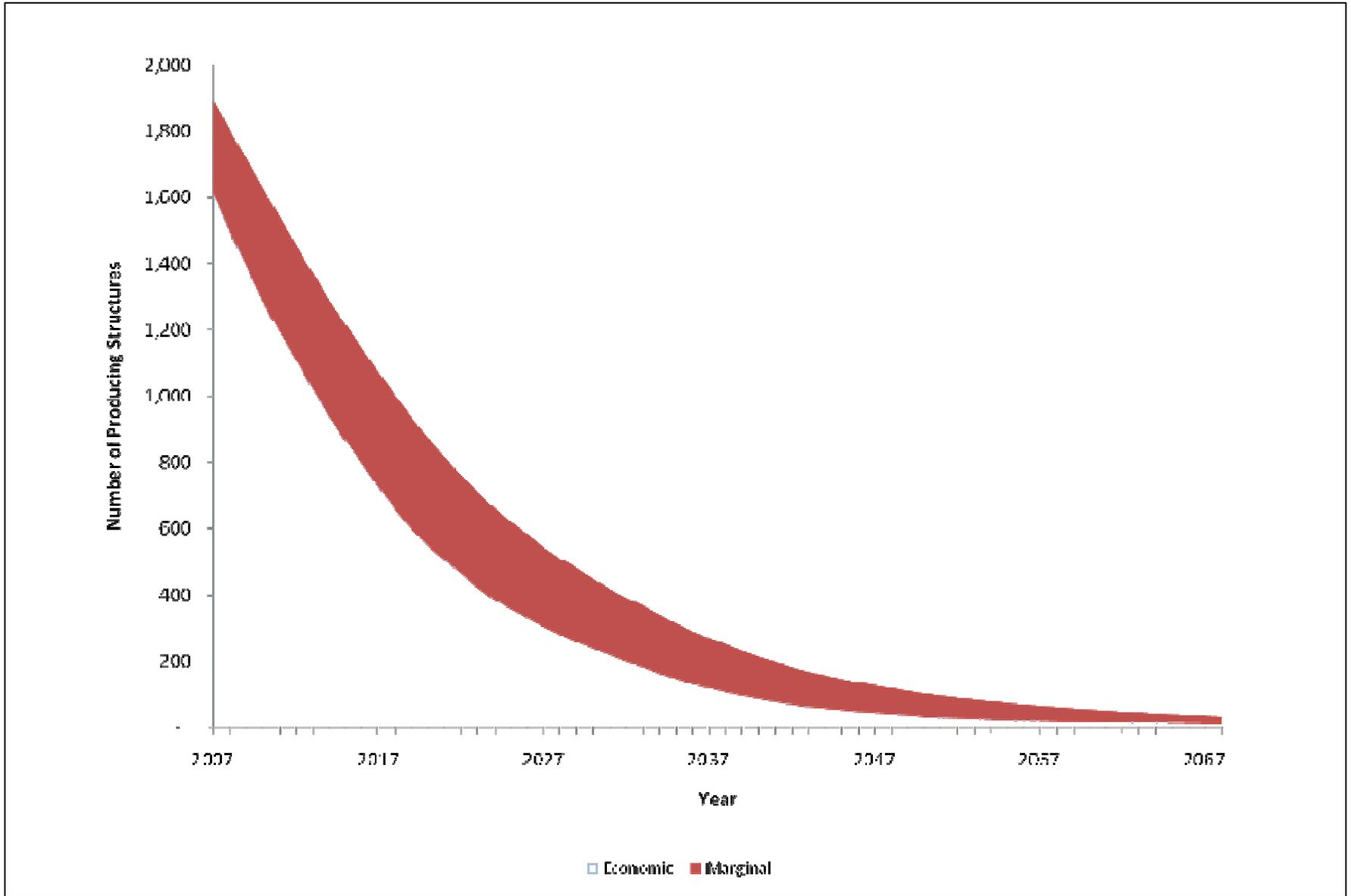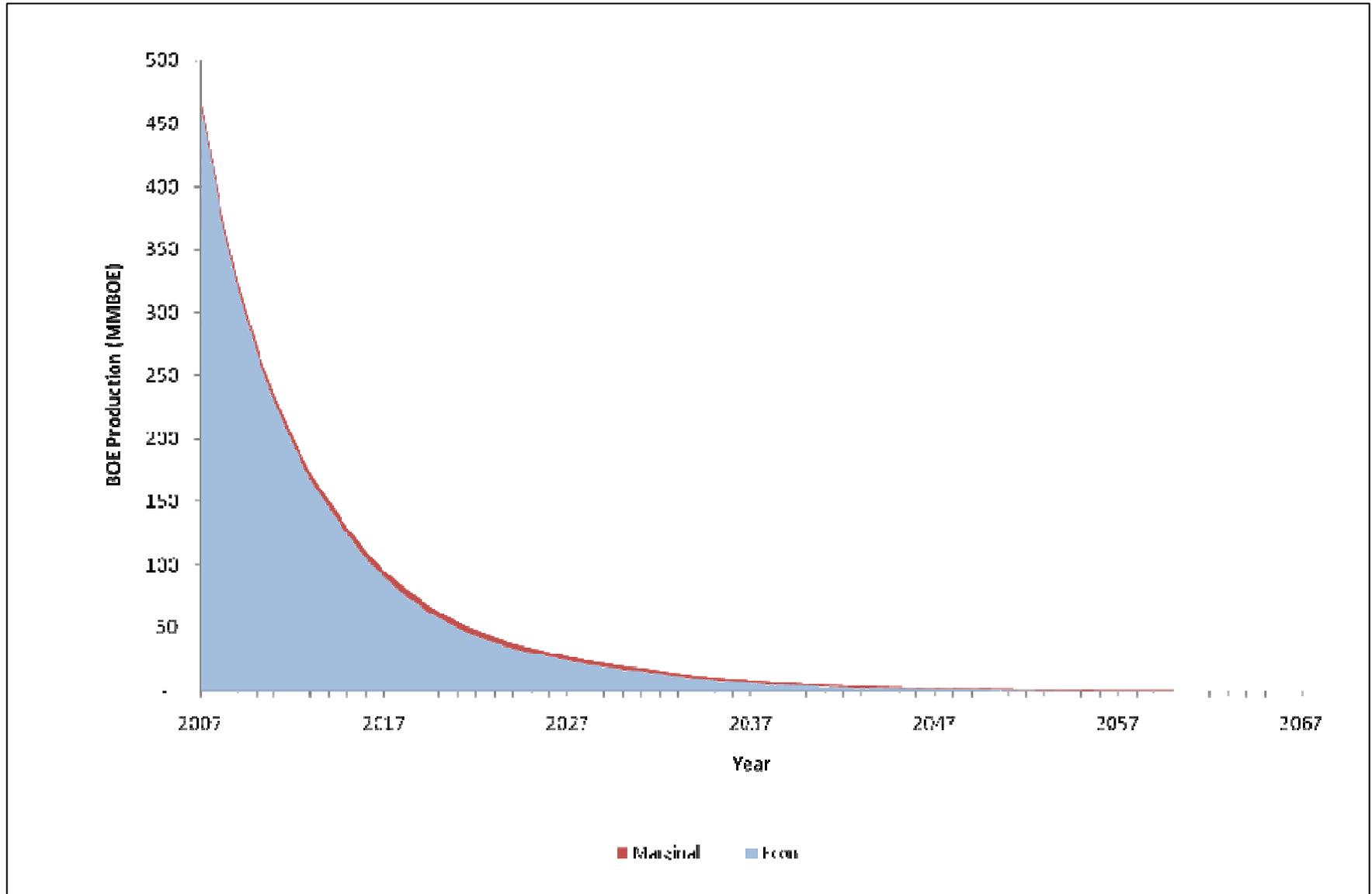
Percentage of Marginal Assets
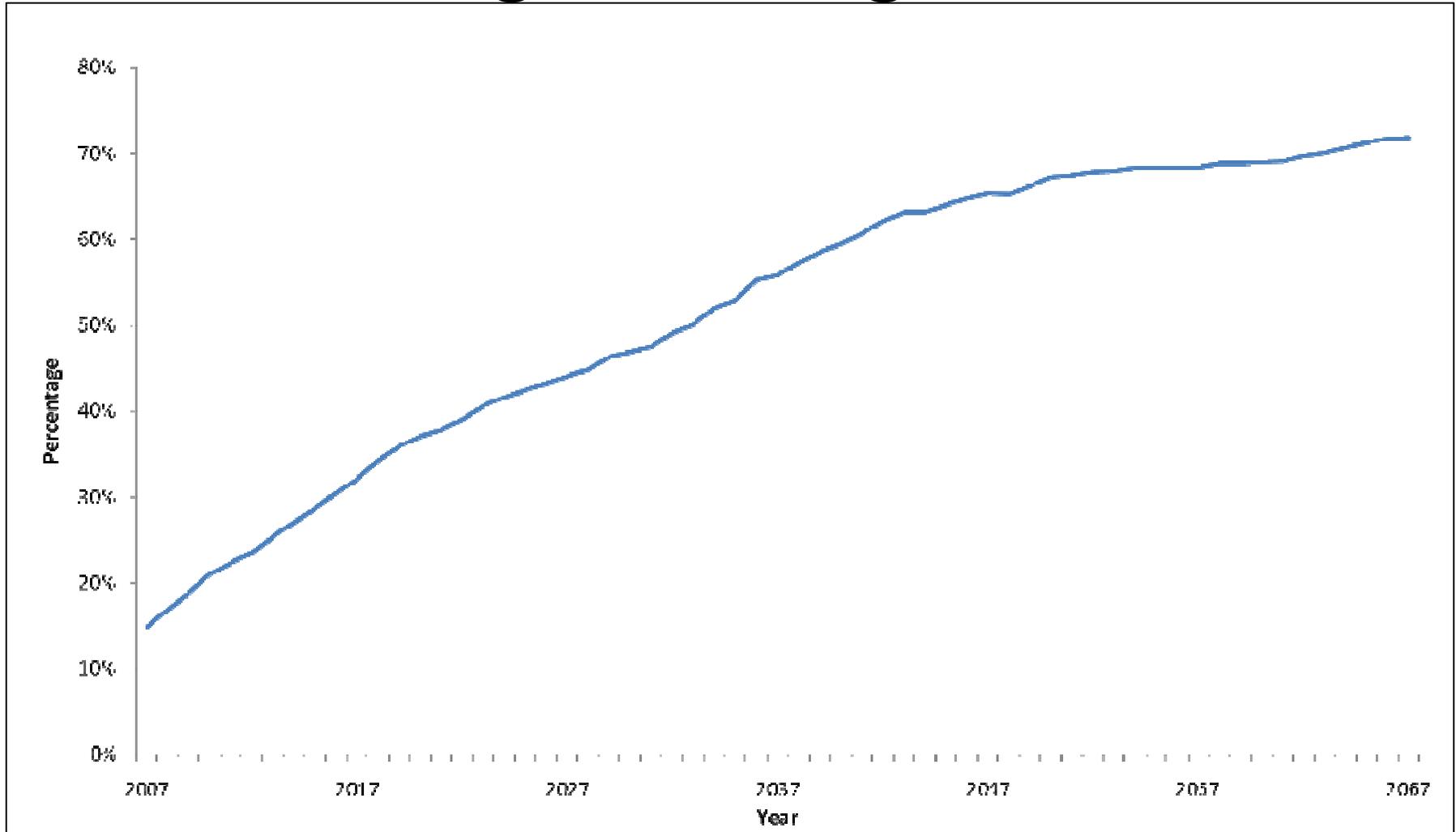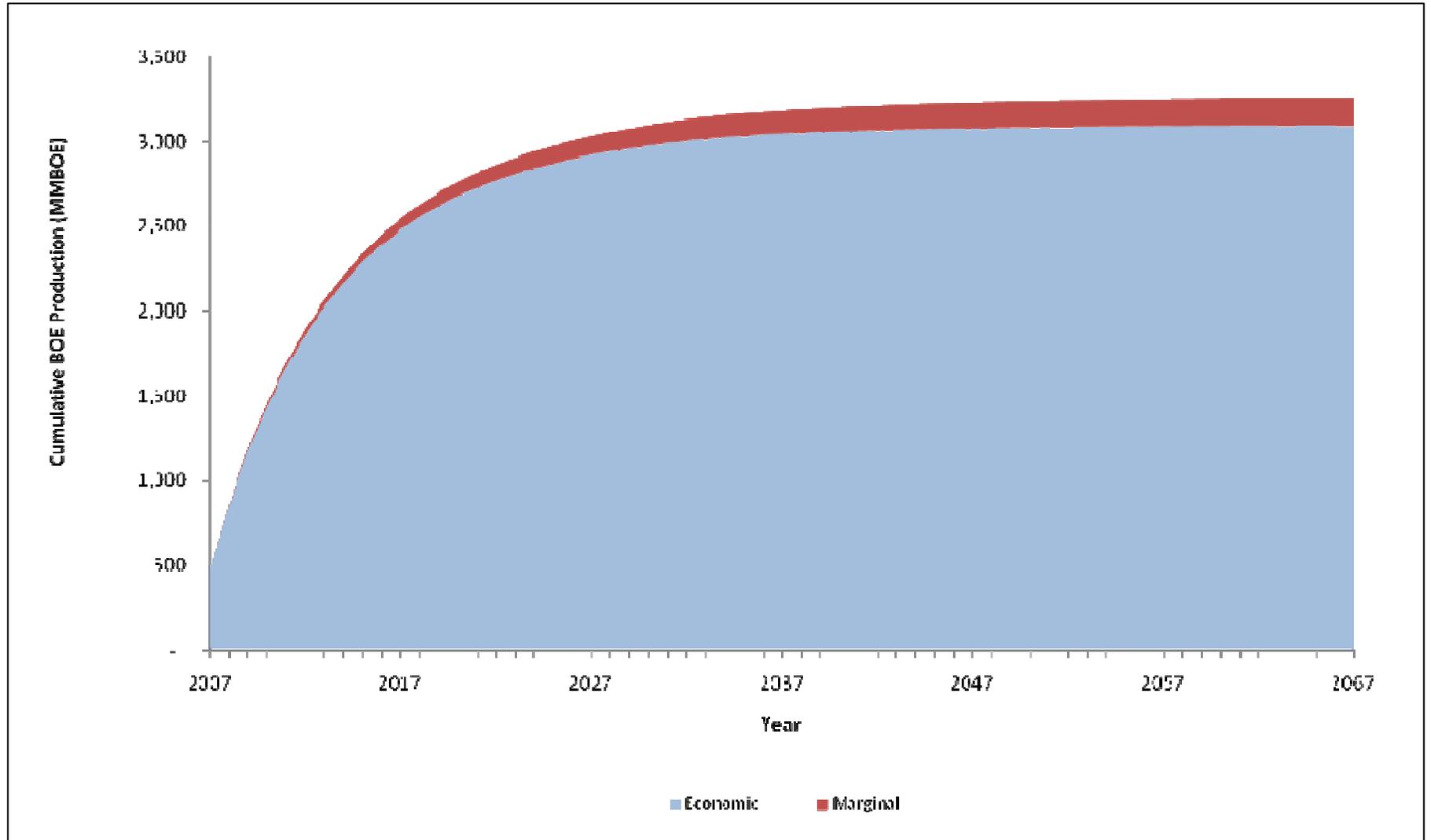
Number of Economic Structures
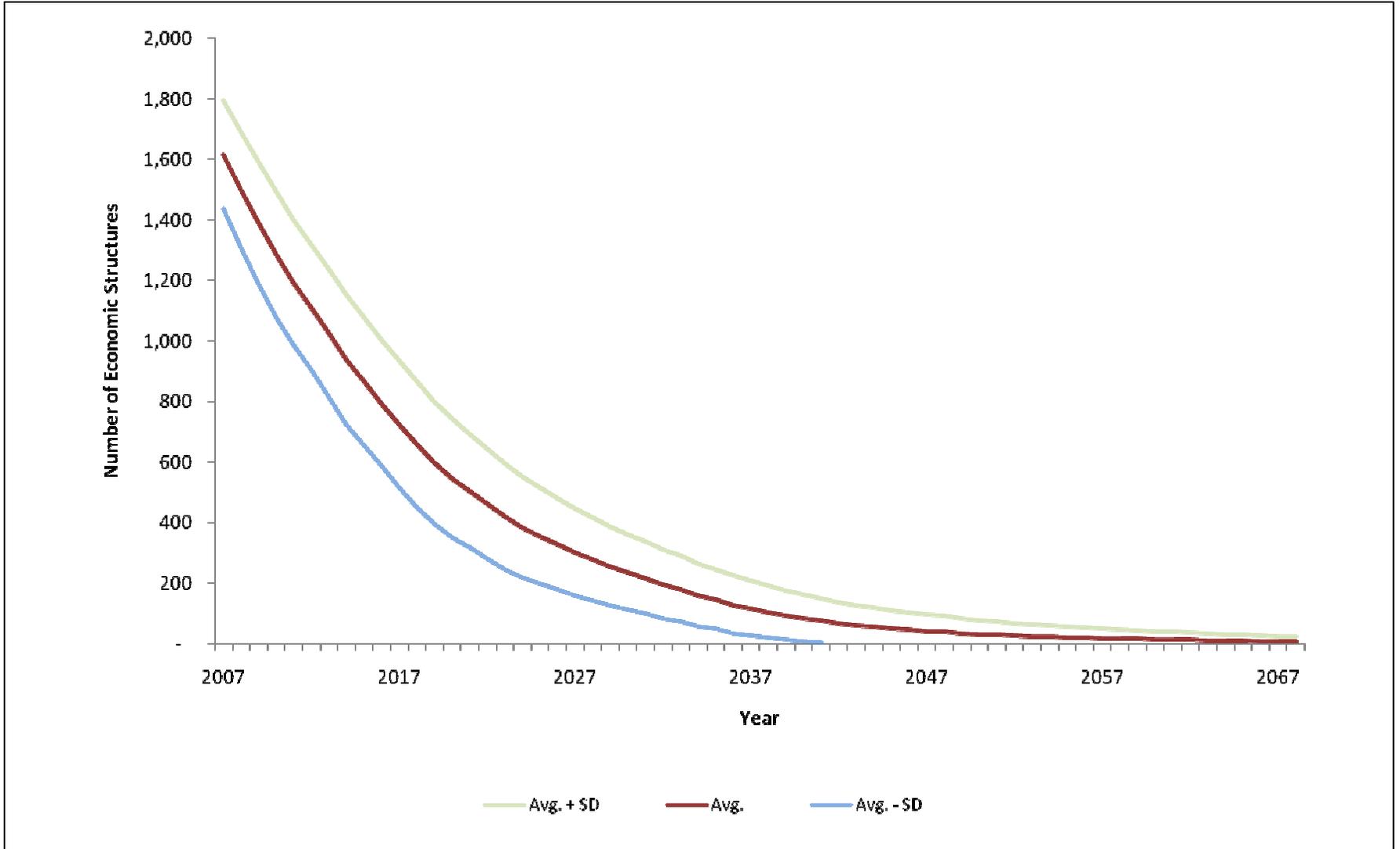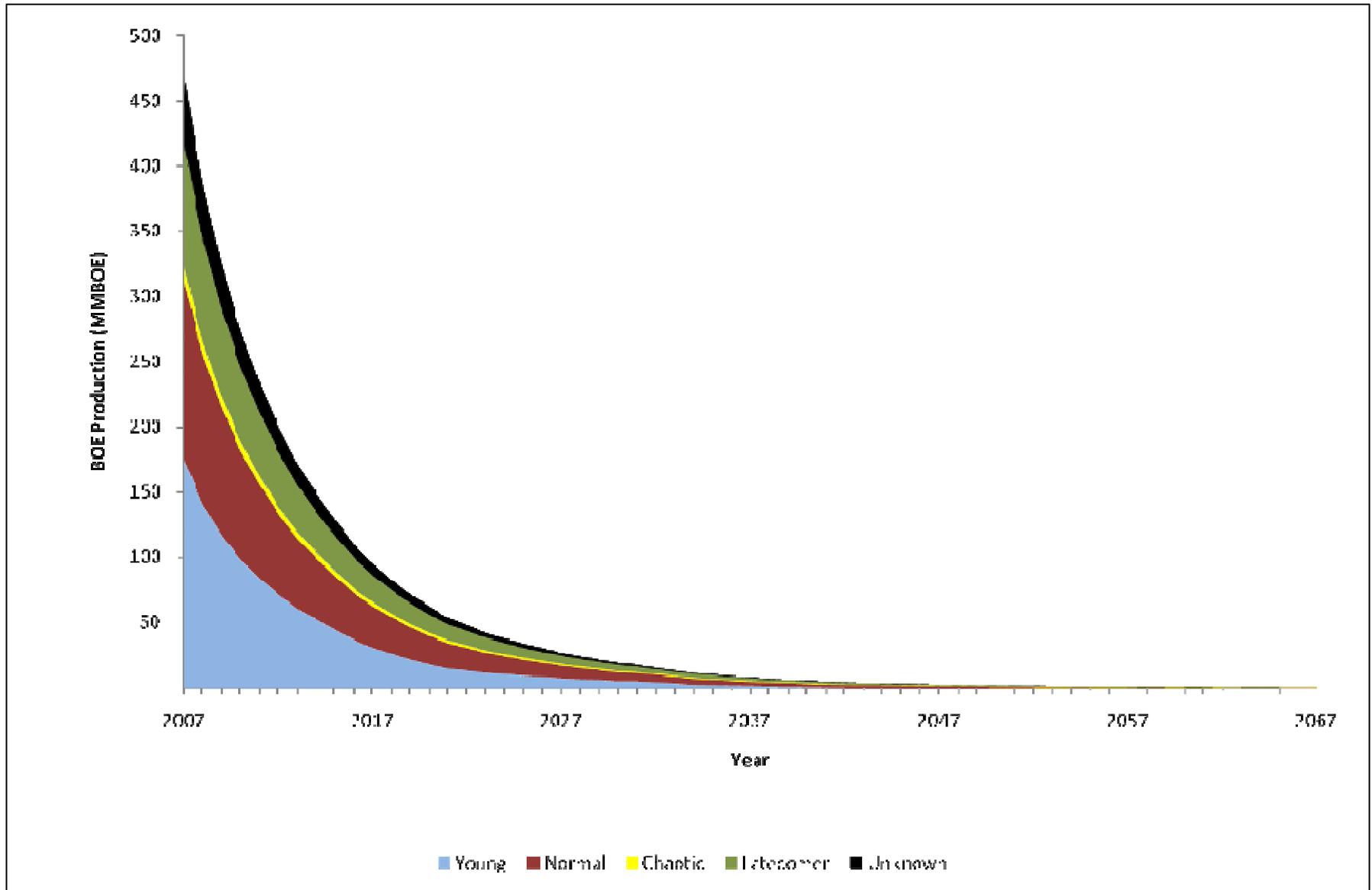
Number of Marginal Structures

Estimated Annual Production

Estimated Cumulative Production

Annual Production by Asset Class
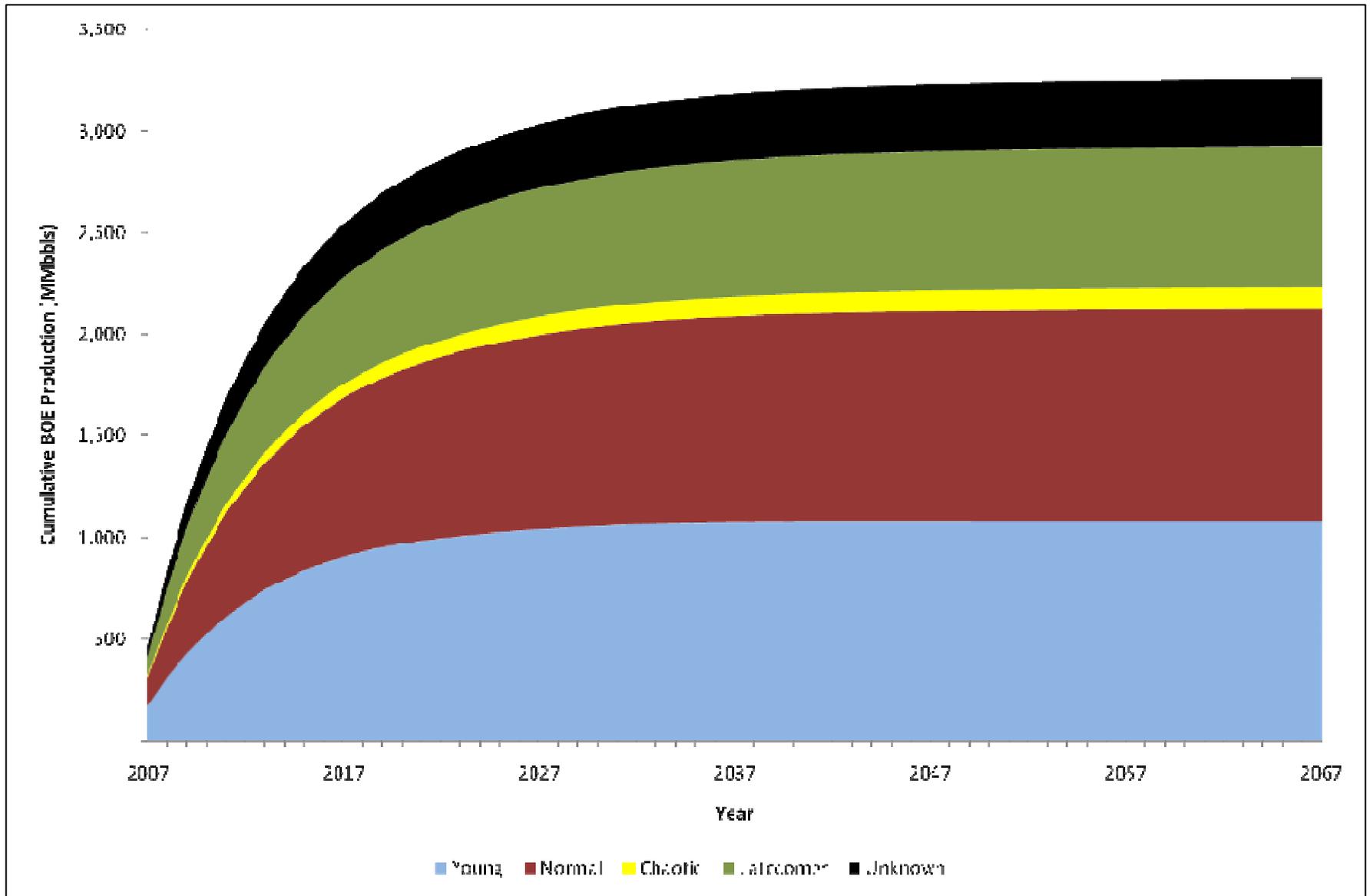
Cumulative Production by Asset Class

Table 4. Summary statistics for shallow water committed assets in the GOM

Production (unit)	Economic	Marginal	Total
Oil (MMbbl)	1,013	44	1,056
Gas (Bcf)	12,622	717	13,338
BOE (MMBOE)	3,116	163	3,279
PV ($ billion)	147.7	1.7	149.4