

# Oil Policy/Security

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The Energy @ Stanford & SLAC conference

Energy Policy Analysis

September 16, 2011

# Three Pieces of Presentation on Oil Security

- The World Oil System:  
Configuration and Magnitude
- Oil Economics and Policies
- Interactions Between Oil Policy, Other Energy Policies, and International Security Policies

# Scale of World Oil System in 2010

- 84 Million Barrels Per Day
- 3.52 Billion Gallons Per Day
- 30.64 Billion Barrels Per Year
- 1.29 Trillion Gallons Per Year
- 5.1 Barrels or 215 Gallons Per Person Per Year



# Financial Magnitude of World Oil System in 2010

- World
  - \$7.2 Billion Dollars Per Day
  - \$2637 Billion Dollars Per Year
  - Approx. 4%+ of GWP
- U.S.
  - \$1.7 Billion Dollars per Day
  - \$628 Billion Dollars per Year
  - Approx. 4%+ of GDP



# Strategic World Oil Balance (2009)

Country/Region	Millions of Barrels Per Day			2009 US\$ Per BBL
	Oil Production	Oil Consumption	Imports(+)/ Exports (-)	Production Costs
U.S.	8.3	18.7	10.4	\$20.00
EU	4.1	13.2	9.1	\$20.00
Japan	0	4.4	4.4	\$40.00
OOECD	6	9.5	3.5	\$20.00
Econ. in Transition	13.6	6.2	-7.4	\$18.00
Middle East	24.4	7.1	-17.3	<\$5.00
Other OPEC	7.9	2.8	-5.1	\$18.00
China	3.8	8.6	4.8	\$20.00
India	0.8	3.2	2.4	\$20.00
Other Dev. Countries	11.1	10.3	-0.8	\$20.00
TOTAL	80	84	4	

# Proved Oil Reserves

Proved reserves at end 2009  
Thousand million barrels



402.2  
Asia Pacific

352.3  
North America

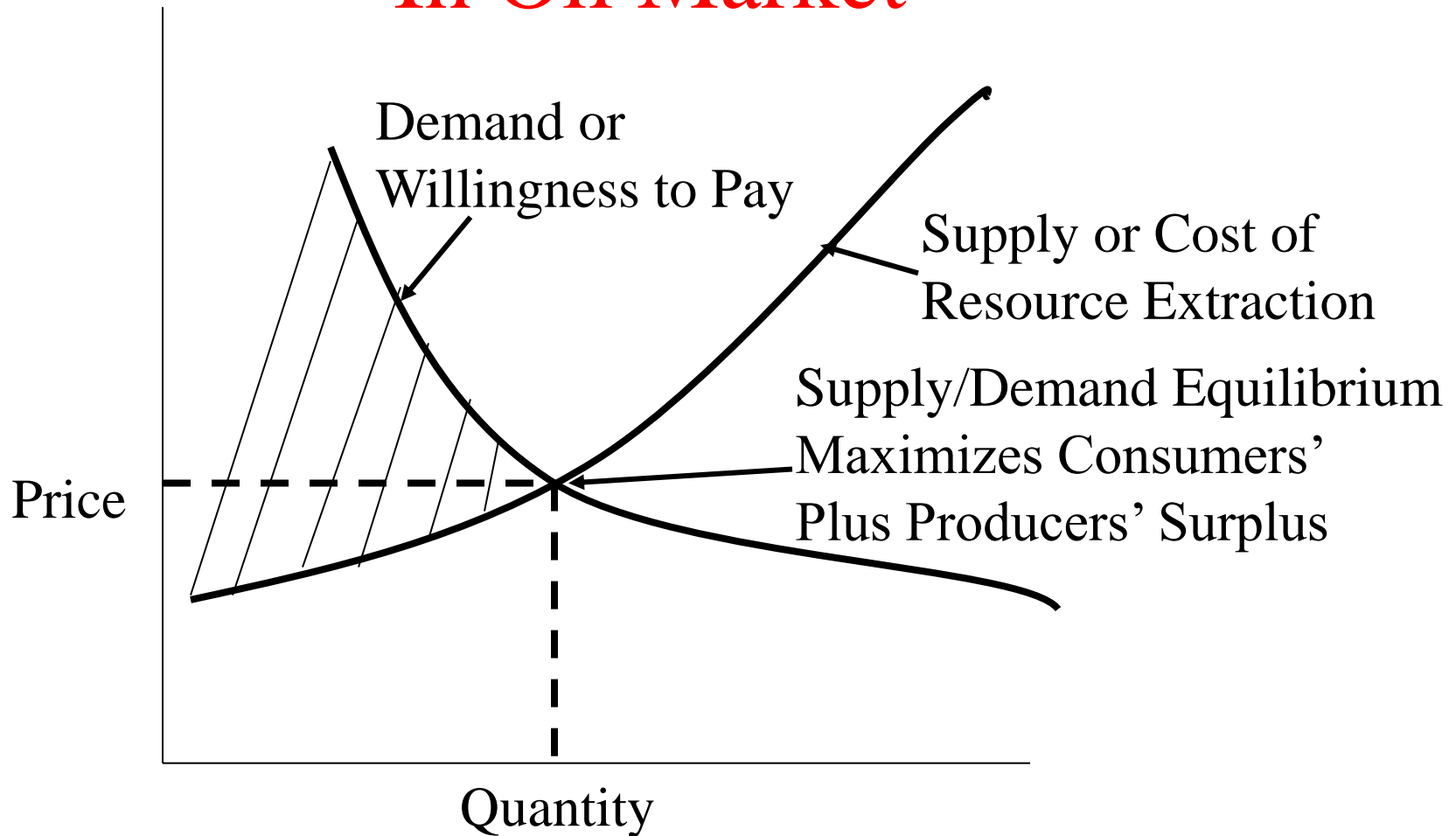
127.7  
Africa

136.6  
Europe & Eurasia

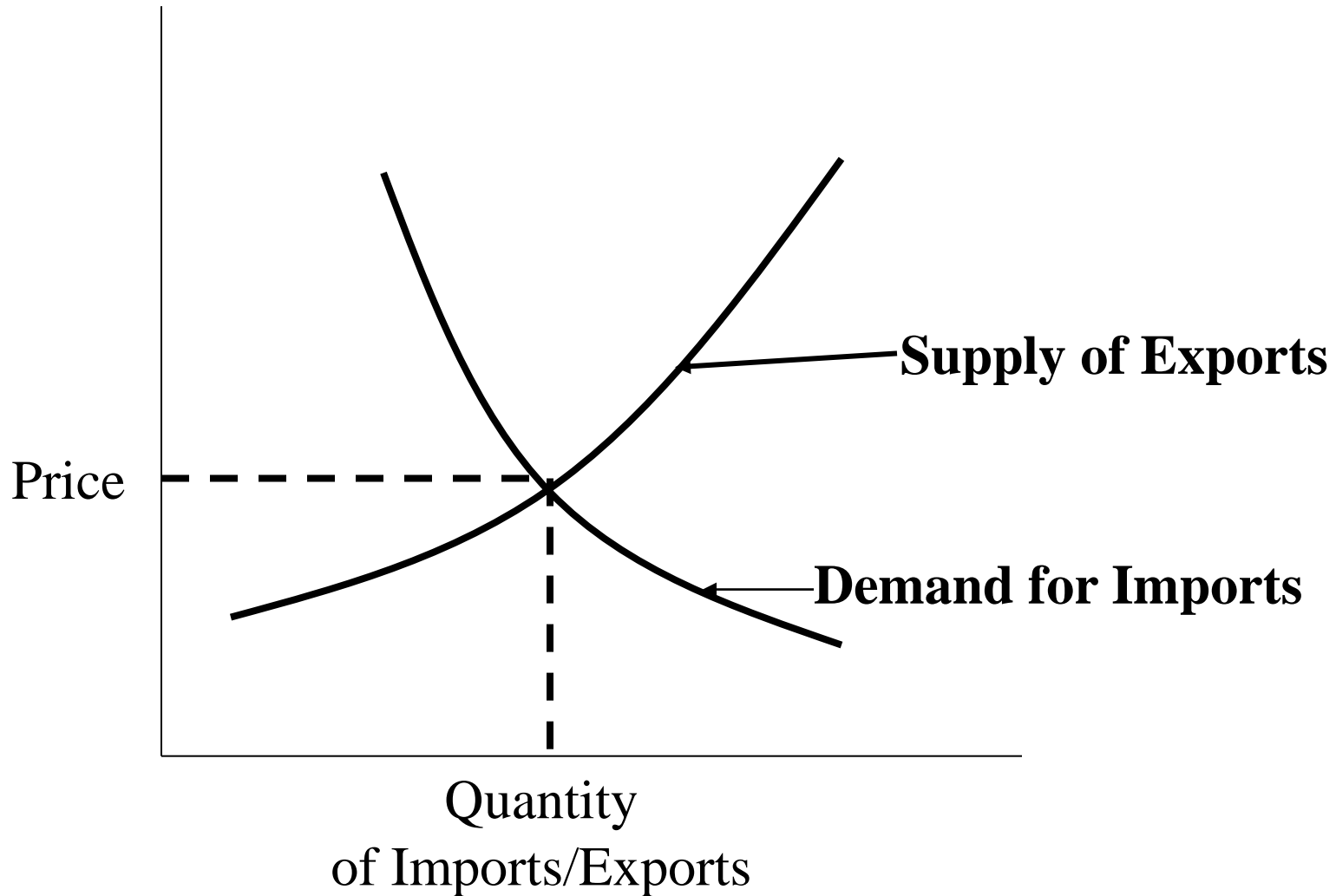
199.8  
S. & Cent. America

754.2  
Middle East

# Supply/Demand Equilibrium In Oil Market



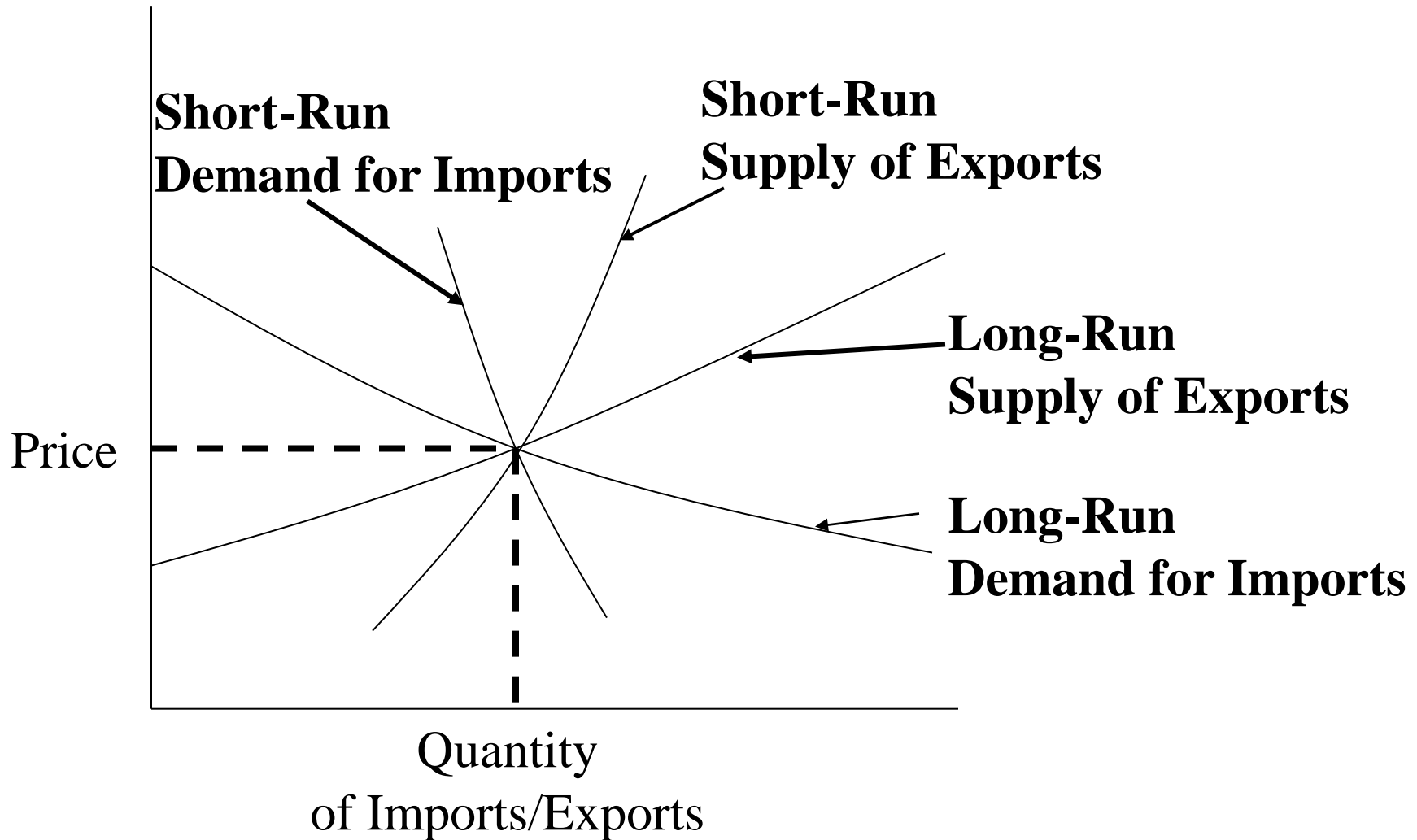
# Supply/Demand For Imports/Exports of Oil





# Long Run and Short Run

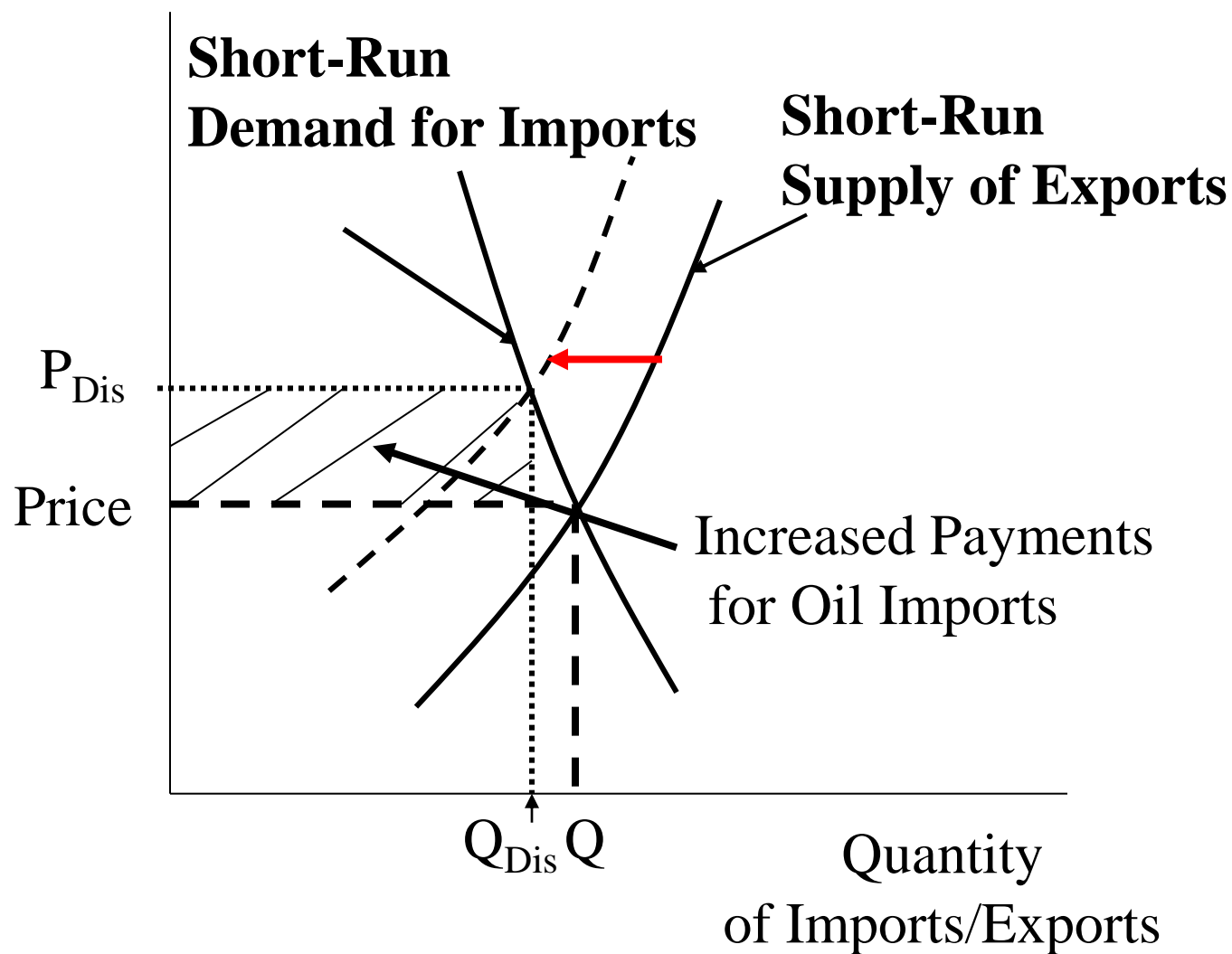
## Supply/Demand For Imports/Exports of Oil



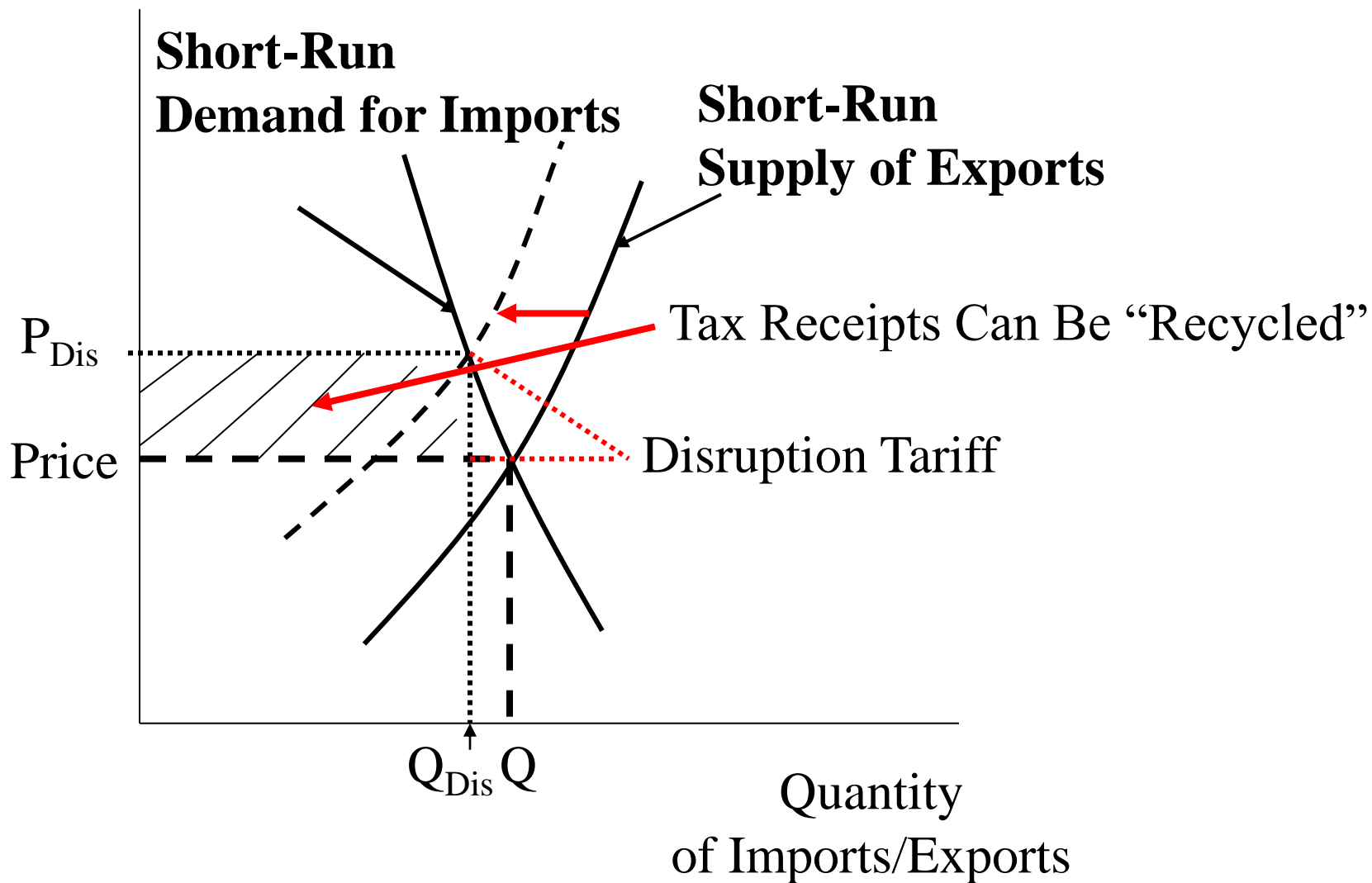
# Some Other Oil Wells



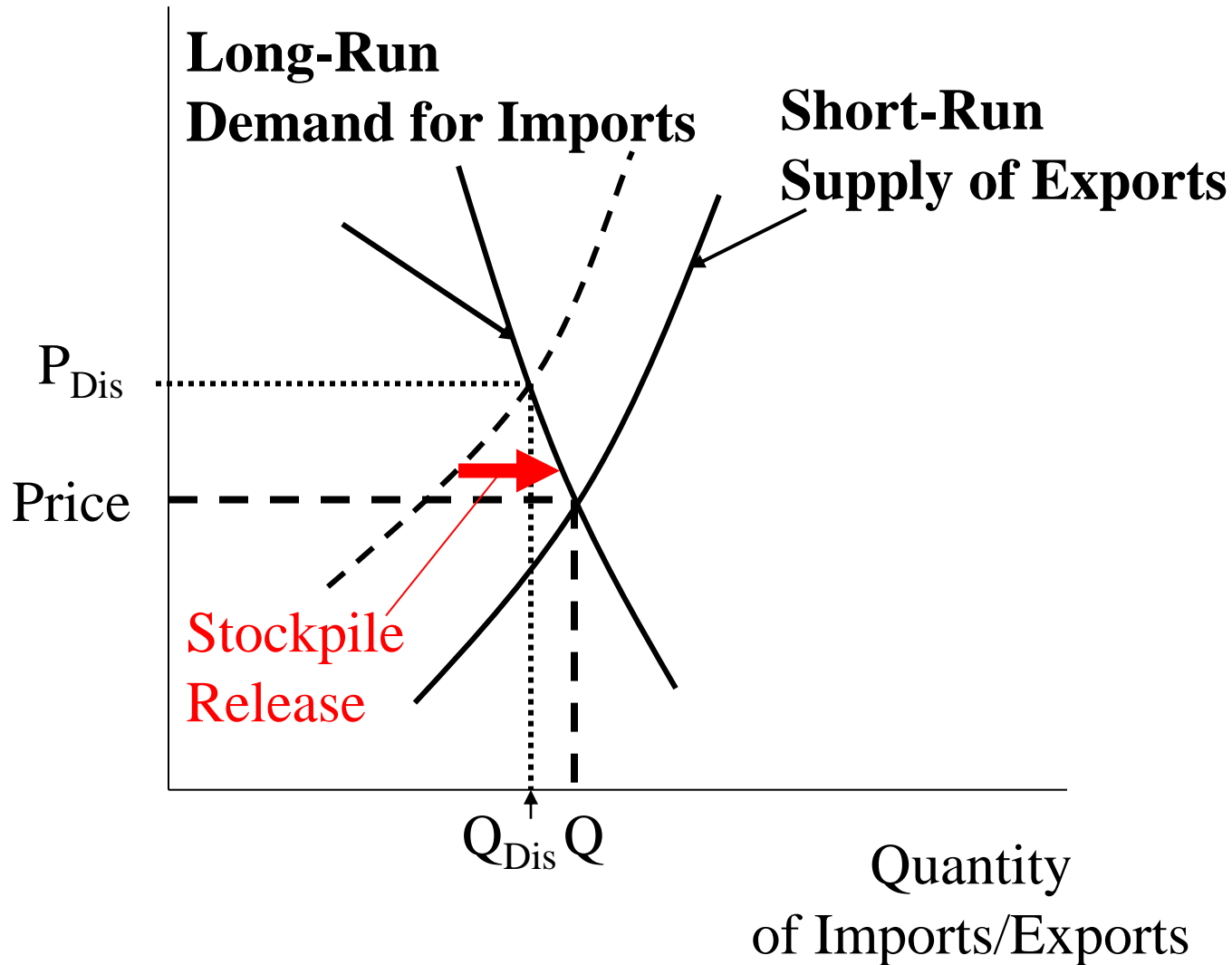
# An Oil Supply Disruption



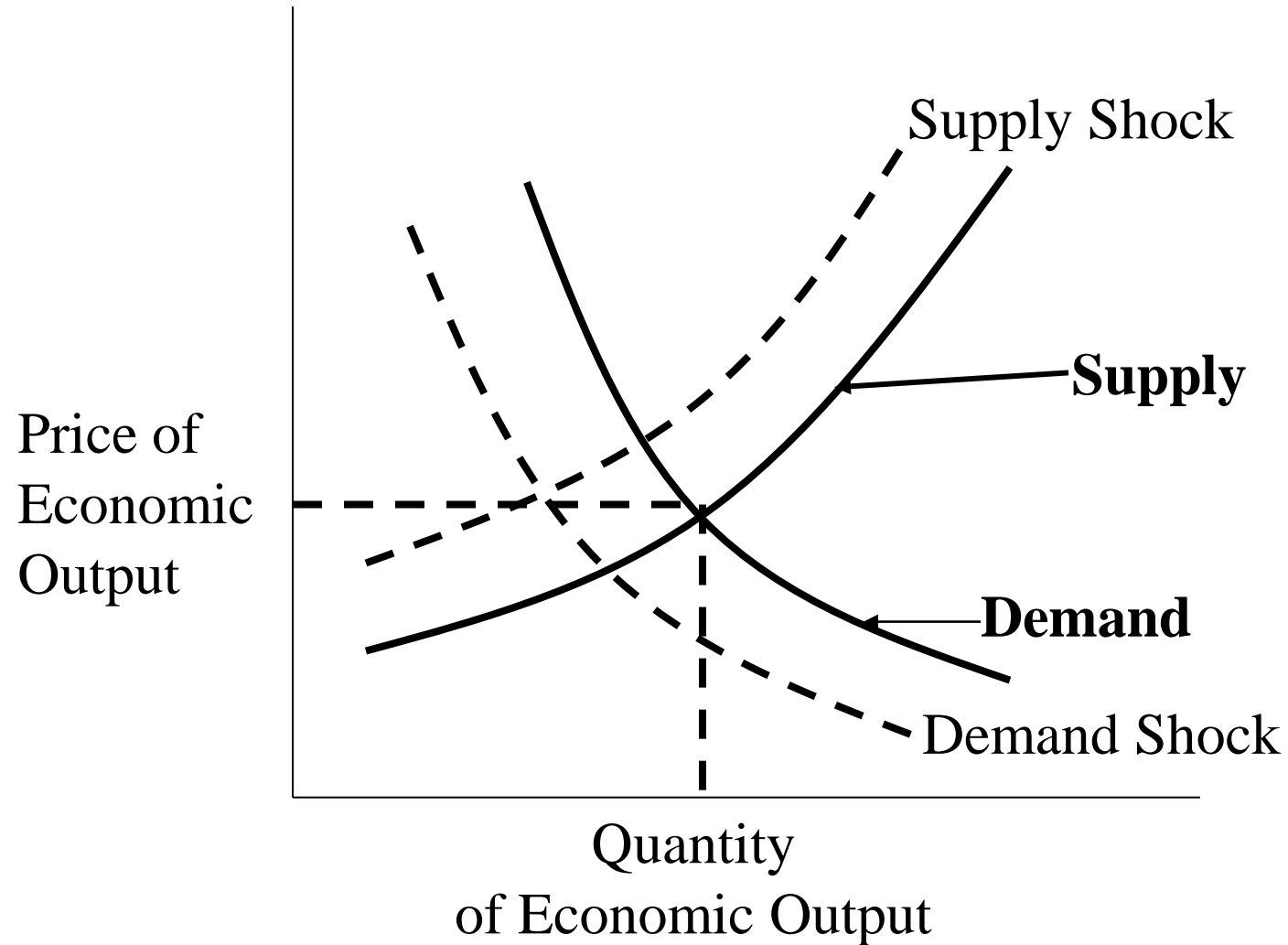
# Oil Supply Disruption Tariff



# Oil Stockpile Release



# Shock Economics



# Shock Economics

- Macroeconomic Costs Driven by Sticky Wages/Prices That Cause Unemployment
- This Happens Because Labor is Worth Less With Less Energy, But Wage Rate Can't Decline
- This Means Short Run Macro Costs Are More Directly Related to Oil Consumption Than Oil Imports Unless Domestic Production is Price Controlled

# Dependence Versus Vulnerability

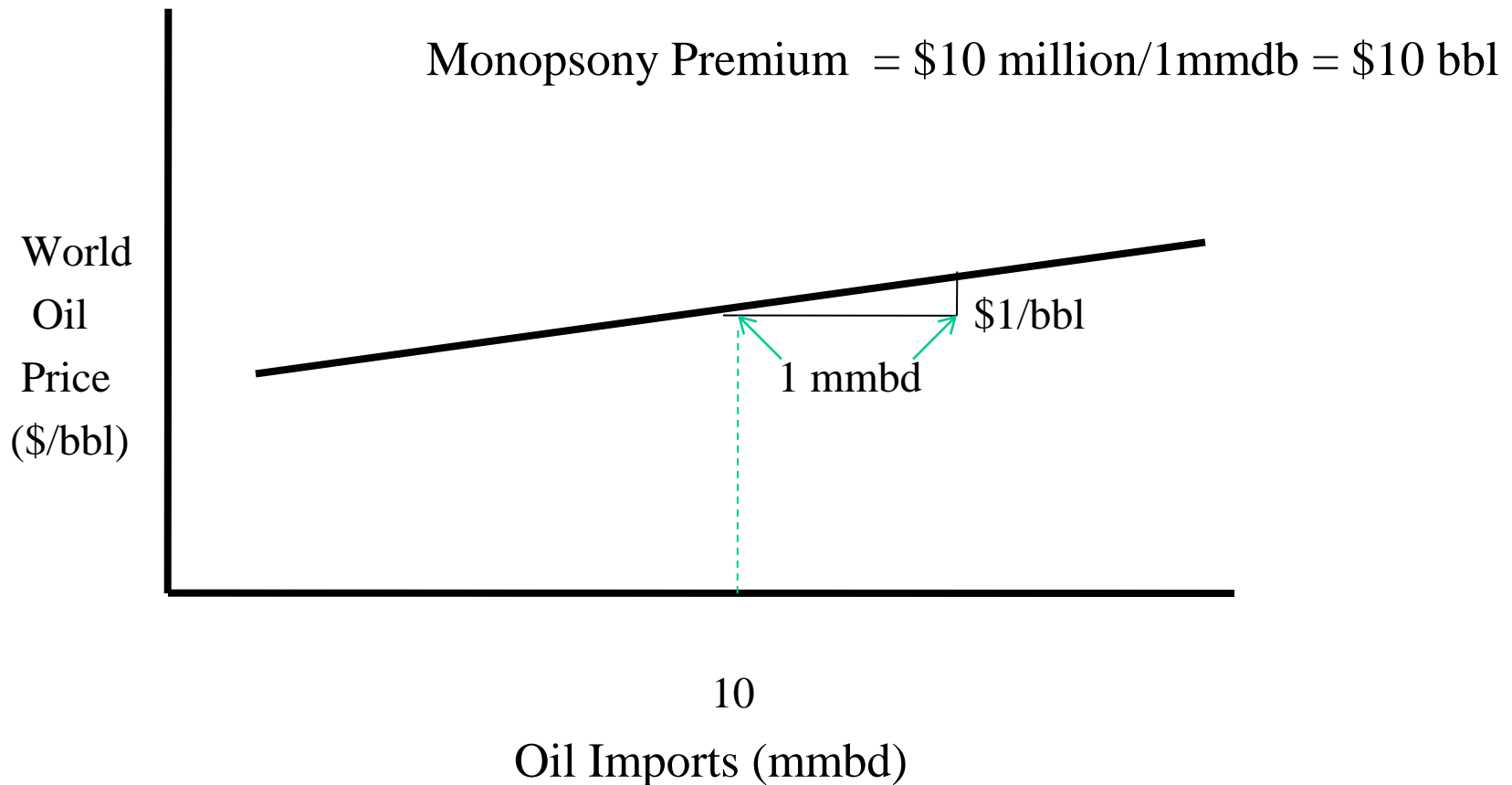
- Dependence is Related to How Much of Our Oil (or Energy) Comes From Imports
- Vulnerability is Related to How Costly it Would Be If There Was A Sudden Disruption in Oil Imports
- Although Higher Dependence Generally Implies Greater Vulnerability, The Two Need Not Be Strongly Correlated



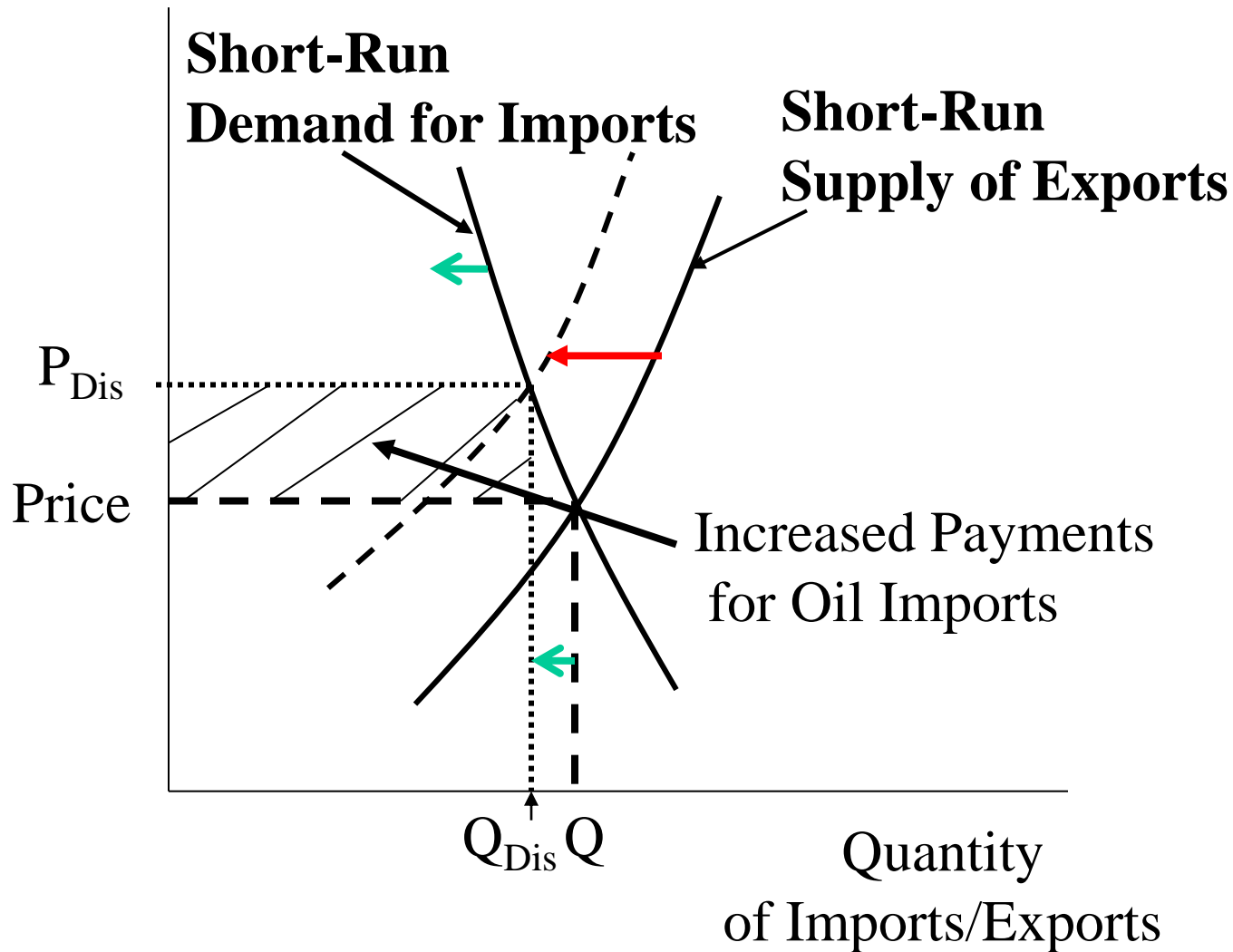
# “Optimal” Oil Import Tariff/Premium Consists of Two Components

- “Monopsony” Component Measures Value of Putting Downward Pressure on the World Price of Oil
  - Usually Estimated to be About \$5-10 per Barrel
  - Depends on What is Assumed About Producer Response
  - Can Include Extra Cost of Terrorism Sponsored by Oil Revenues
- “Vulnerability” Component Measures Value of Having Less Oil to Make Up For When A Sudden Supply Disruption Occurs
  - Expected Value Usually Estimated to be About \$5-10 per Barrel
  - Depends on The Policies in Place to Respond to the Disruption
  - Can Include Extra National Defense and Diplomacy Costs

# Monopsony Premium Example



# Vulnerability Premium Has Both Import Level and Disruption Size Effects



# **Quantifying Oil Disruption Risks through Expert Judgment**

## **FINAL REPORT**

November 25, 1996

*Prepared by:*

**Hill Huntington**

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**Phil Beccue**

**APPLIED DECISION ANALYSIS, INC.**

# Sketch of EMF Approach

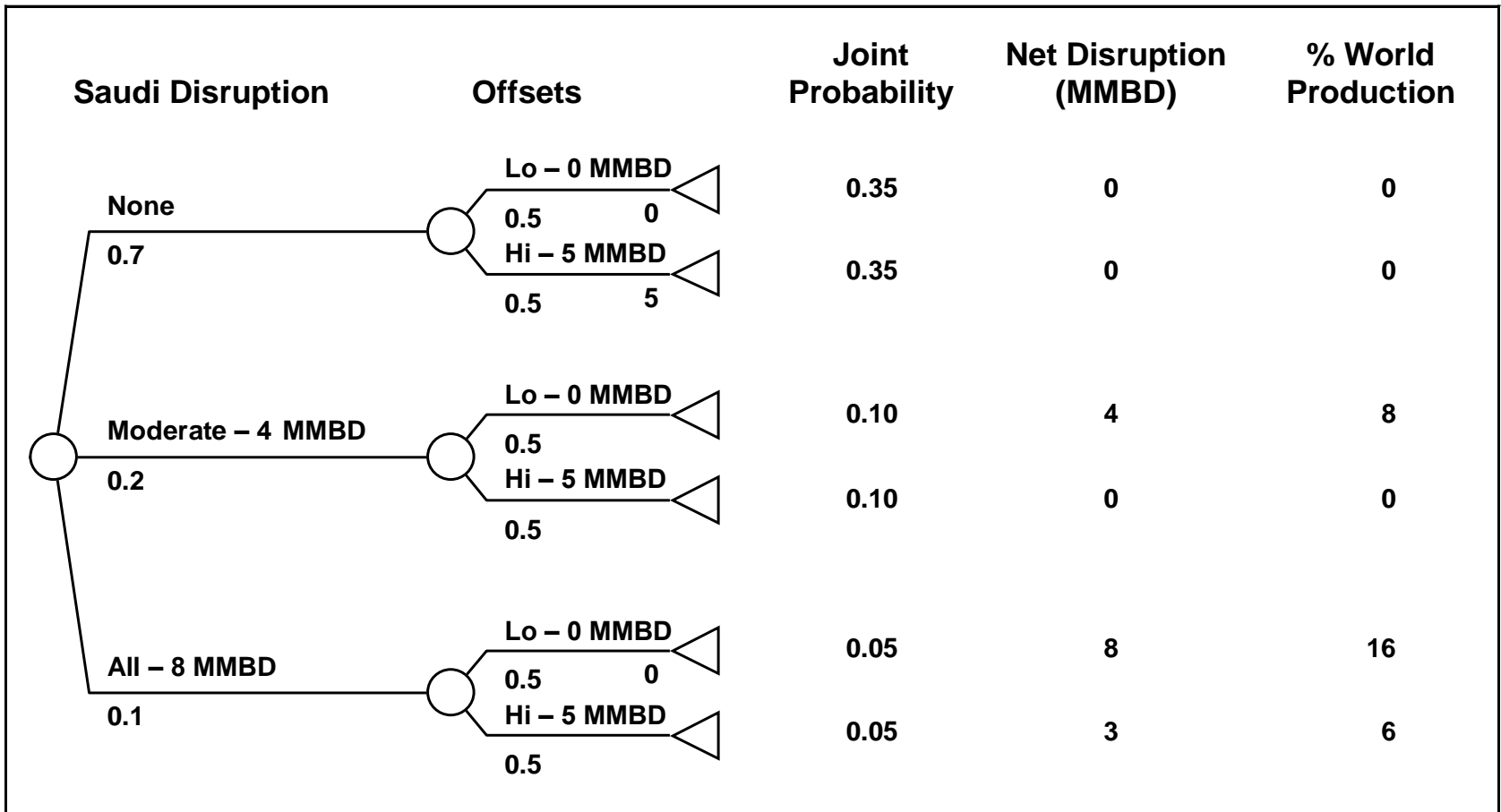


Figure 1. Probability tree for performing risk assessment computations

# Actual EMF Approach

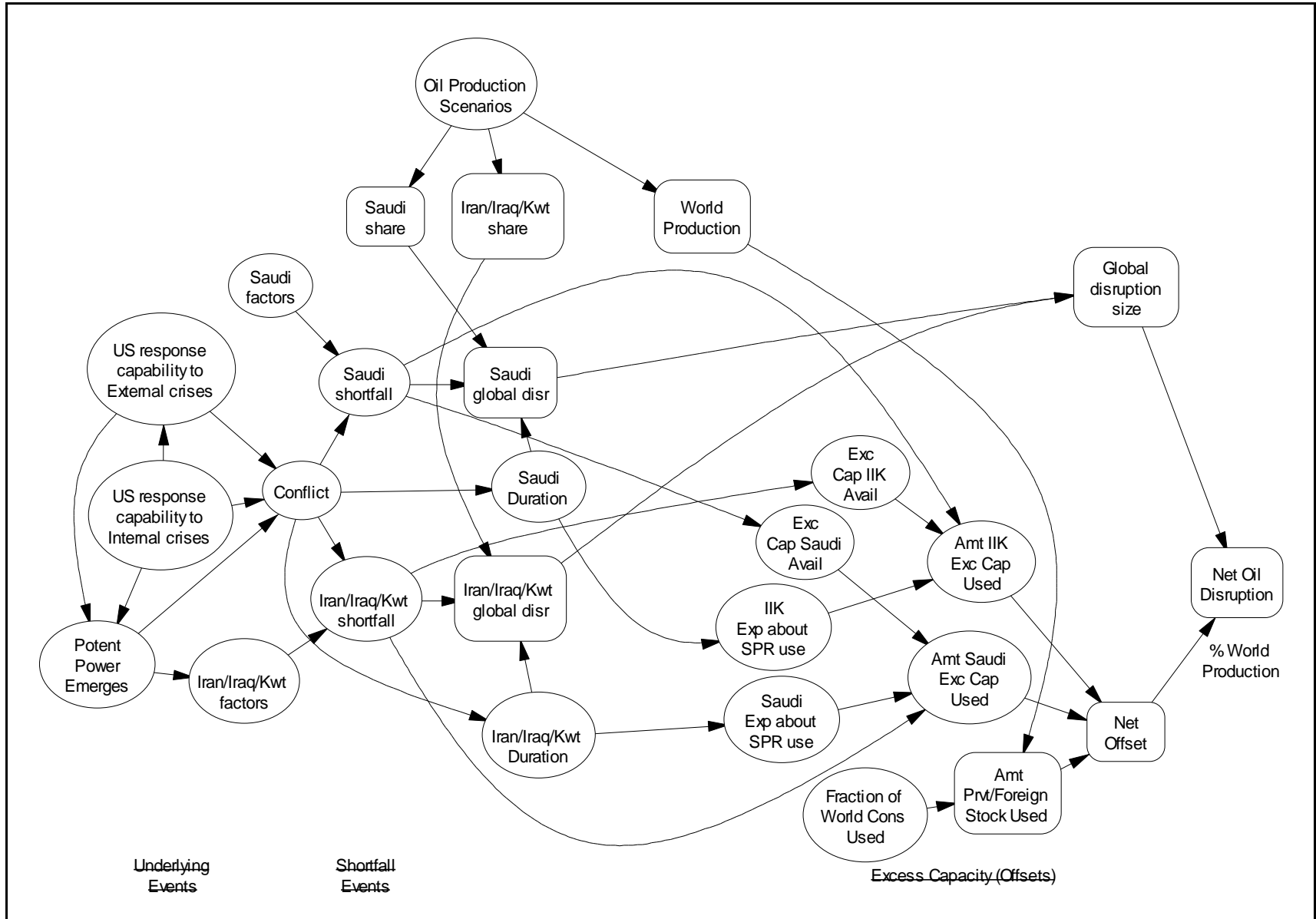
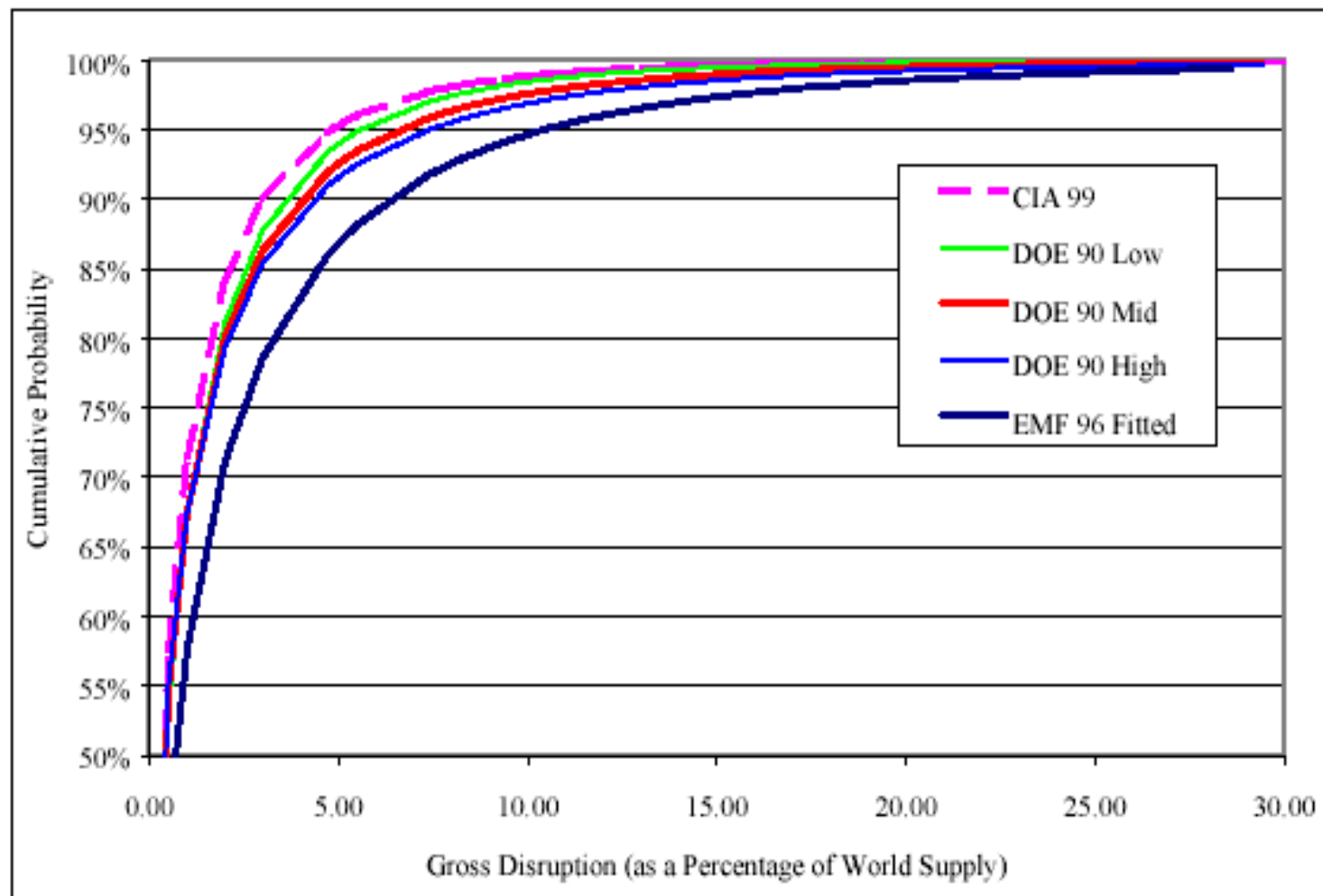


Figure 1. World Oil Disruption Influence Diagram.



**Figure 8:** Comparing Disruption Probabilities. Cumulative Probability Distributions (Probability of Disruption with Size  $\leq$  Given Percentage of Supply) from DOE 1990 Study, EMF 1996 Assessment, and CIA1999.

# **The Value of Expanding the U.S. Strategic Petroleum Reserve<sup>1</sup>**

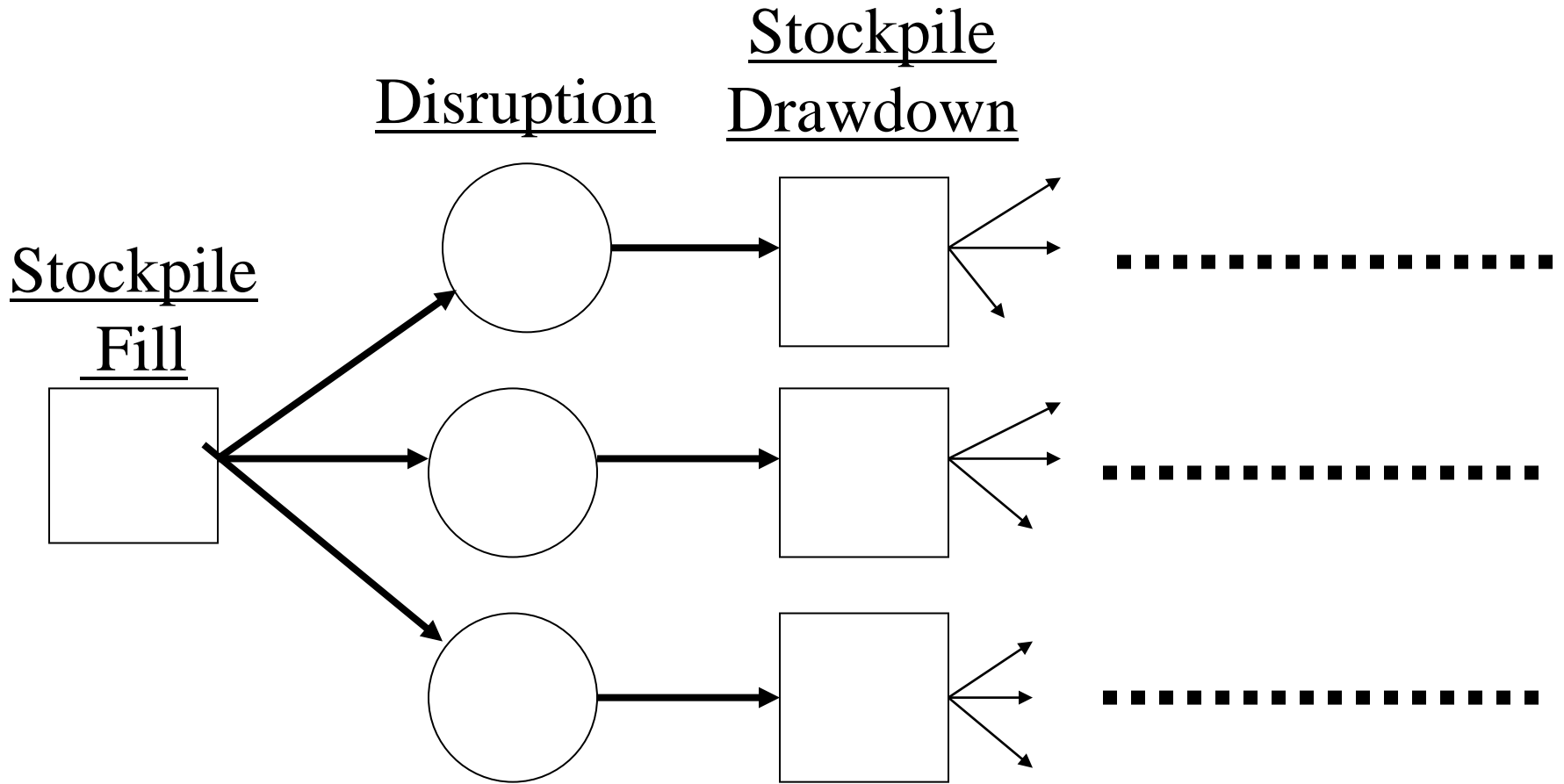
Paul N. Leiby<sup>2</sup> and David Bowman,

Oak Ridge National Laboratory

November 30, 2000

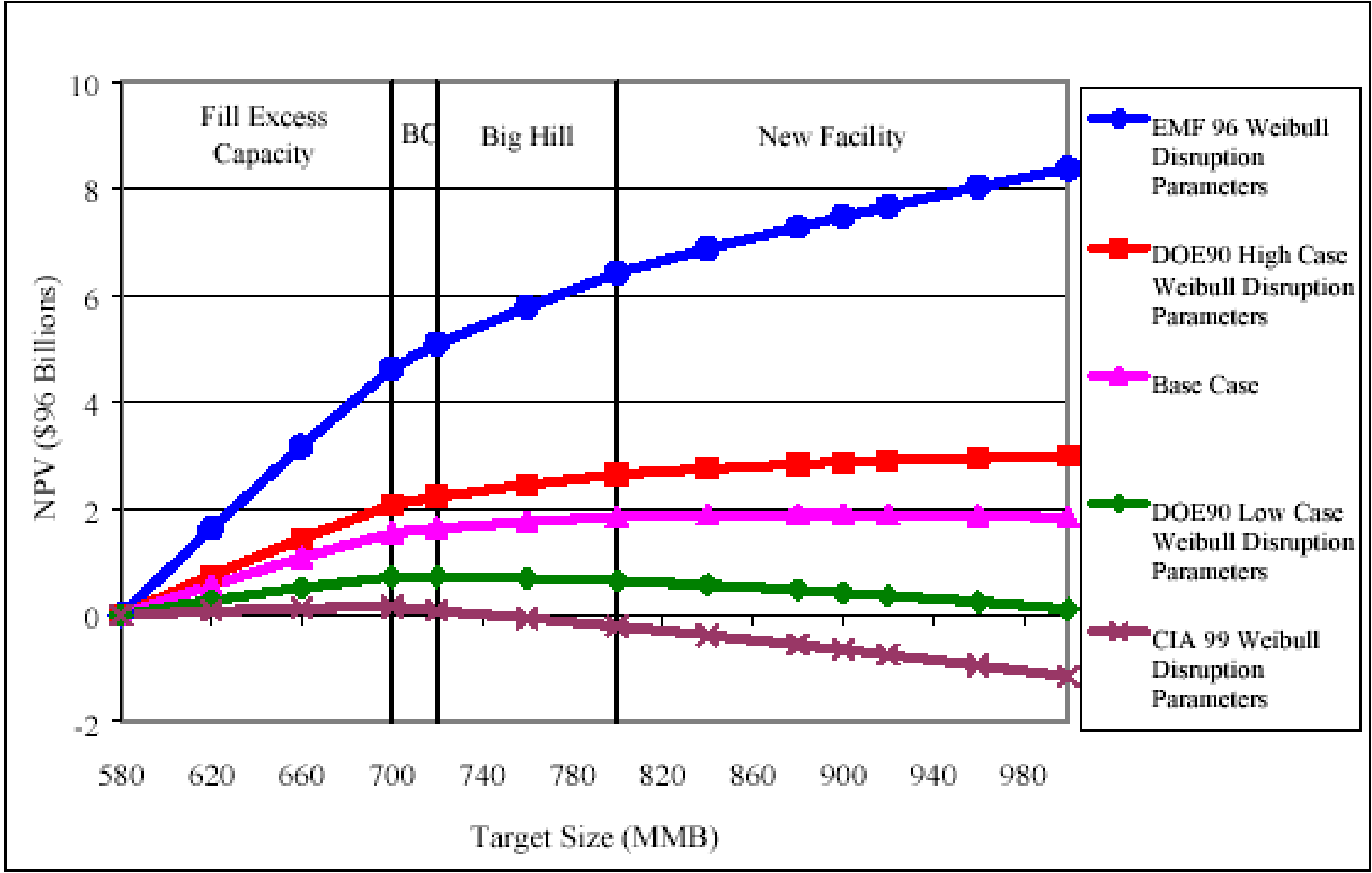


# Strategic Oil Stockpile Size Problem



# Disruption Cost Model: Two Basic Cost Components

- Wealth Transfer in Terms of Higher Payments for Oil Imports + Net Surplus Loss
  - Change in Price Of Oil During Disruption Times  
Average of Quantity of Pre- And Post-Disruption Oil Imports
- A Dis-Equilibrium Macro-Economic GDP Effect
  - % Decrease in GDP = .05 X % Increase in Oil Price



**Figure 18:** Net Economic Benefit of Expansion, Sensitivity to Disruption Probability

# Key Additional Questions

- Can Other Energy Policies Help Reduce Oil Dependence/Vulnerability
- Do Oil Policies Help With International Security
- Does/Should International Security Have an Oil Policy (both Dependence and Vulnerability) Dimension

# Energy Policy Options

- Oil Vulnerability Focused
  - Oil Stock Piling
  - Options and Futures Market Deepening
  - Other Types of Contingency Planning
- Oil Dependence Focused
  - Oil Import Fees
  - Efficiency Standards
  - Substitute Natural Gas for Oil
  - Substitute Nuclear Power for Oil
  - Substitute Energy Efficiency and Renewable Energy for Oil
  - Advanced Energy Technology Development

The End

# Advanced Energy Technology Development

- Could Be A Longer Run Solution
- May be Driven by Environmental Problems
- Global Climate and Energy Project (GCEP)  
Example
- Is a “Revolution in Energy Systems” Likely?

# Multiple Objectives and Policy Options

- Diplomacy
  - Co-operation/Communication With Oil Exporters
  - Co-operation/Co-ordination With Allies
- Military
  - Insure Supply of Oil To Fight Conflicts
  - Contingency Planning
  - Co-ordination With Other Nations
  - Terrorism Defense and Response
- Oil
  - Vulnerability Focused
  - Dependence Focused



# Oil Wells



# Off-Shore Oil Platform



# Oil Pipeline



# What's A Barrel of Oil? Measure Equal to 42 Gallons



**Table 6: Key Parameters for Strategic Reserve Size**

<b>Factor</b>		<b>Strength of Influence on Benefits</b>
!	Disruption Size Probability	(+++)
!	Disruption Offsets	(+++)
!	GDP Elasticity	(+++)
!	Disruption Length Probabilities	(++)
!	Discount Rate	(--)
!	Reserve Fill Rate	(++)
!	Import Levels	(++)
!	Import Demand Elasticities	(++)
!	GDP Growth Rate	(+)
!	Maximum Reserve Draw Rate	(+)
!	Oil Price Path	(-)
!	Coordination with Foreign Stocks	(-)
!	Reserve Refill Rate/Policy	(-)
!	Short-run Fuel Switching	(-)

Note: Those parameters that are followed by “plus” signs (+) lead to higher benefits when they are increased in magnitude, and lower benefits when they are decreased. The converse holds true for parameters followed by a “minus” sign (-). The number of pluses or minuses is a rough indicator of the strength of the effect.



“The Strategic Petroleum Reserve is an important element of our Nation's energy security. To maximize long-term protection against oil supply disruptions, I am directing...the Secretary of Energy to fill the SPR up to its 700 million barrel capacity.”

President George W. Bush

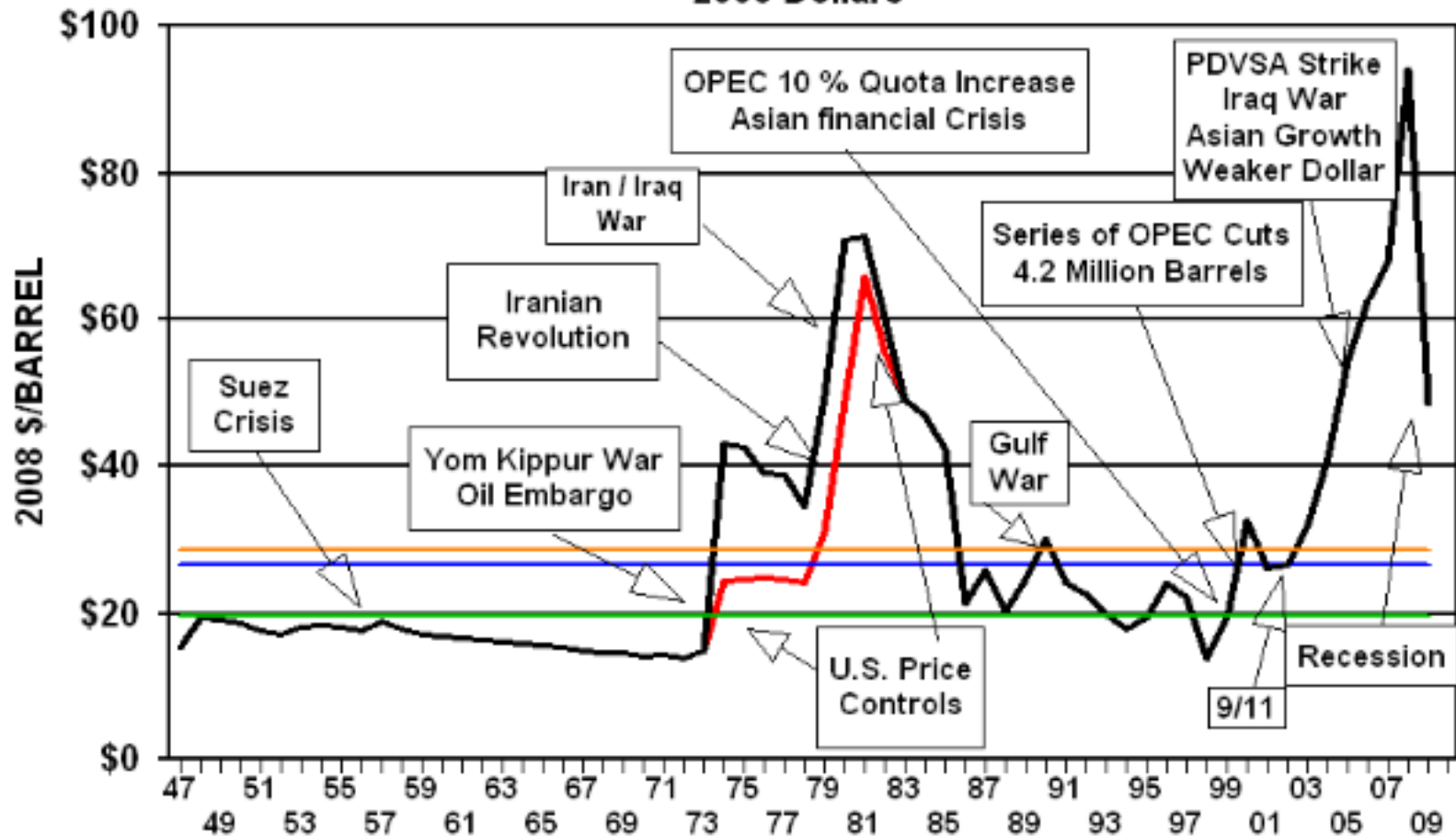
November 13, 2001

# Strategic Petroleum Reserve Inventory for February 6, 2009

Current Inventory			To be Delivered	
Sweet	Sour	Total	Royalty-in-Kind	Exchange 2009
314.6 million bbls	389.2 million bbls	703.8 million bbls	22.1 million bbls	0.6 million bbls

# Model That?

Crude Oil Prices  
2008 Dollars



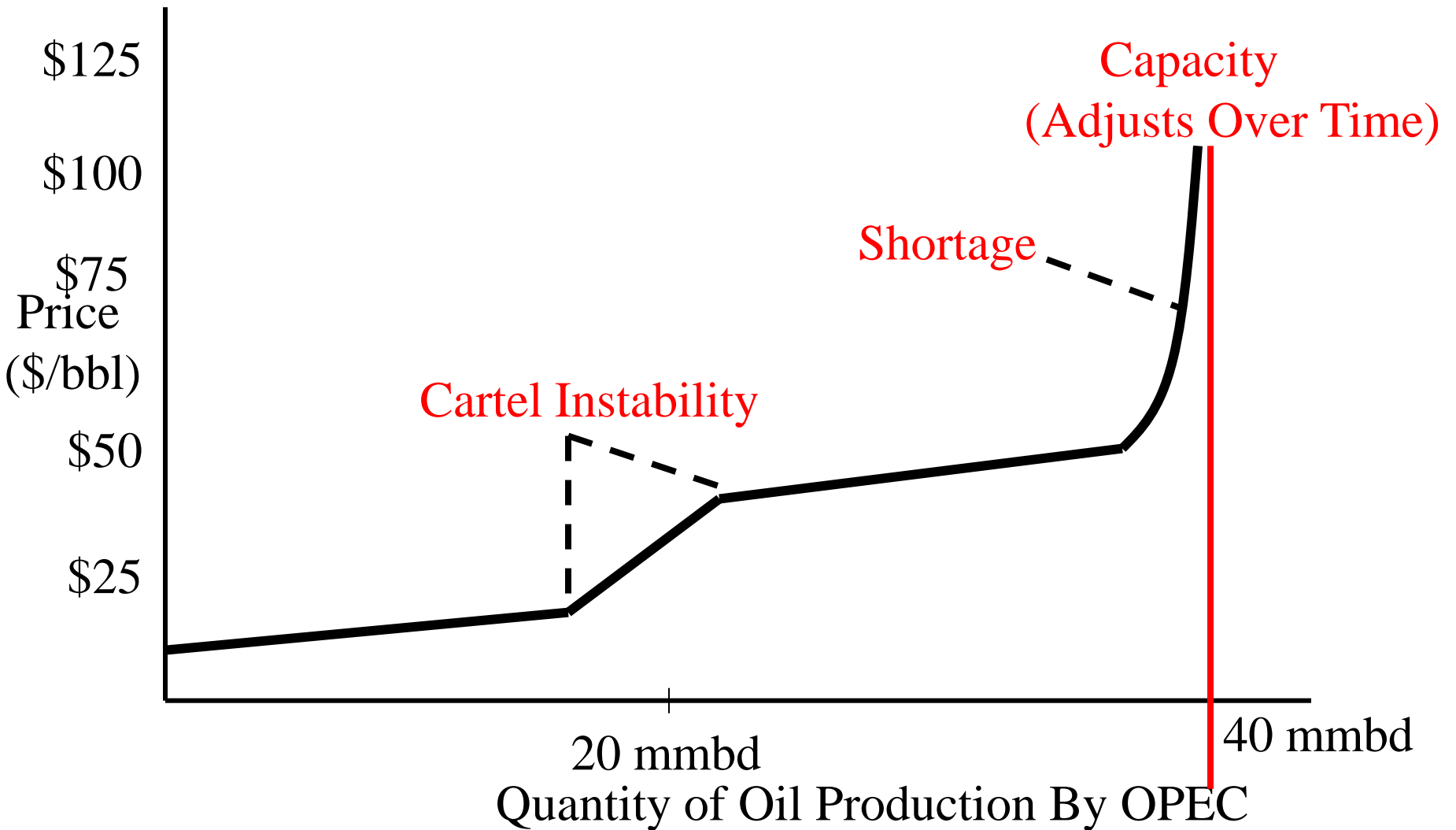
1947 - August, 2009 WTRG Economics ©1998-2009

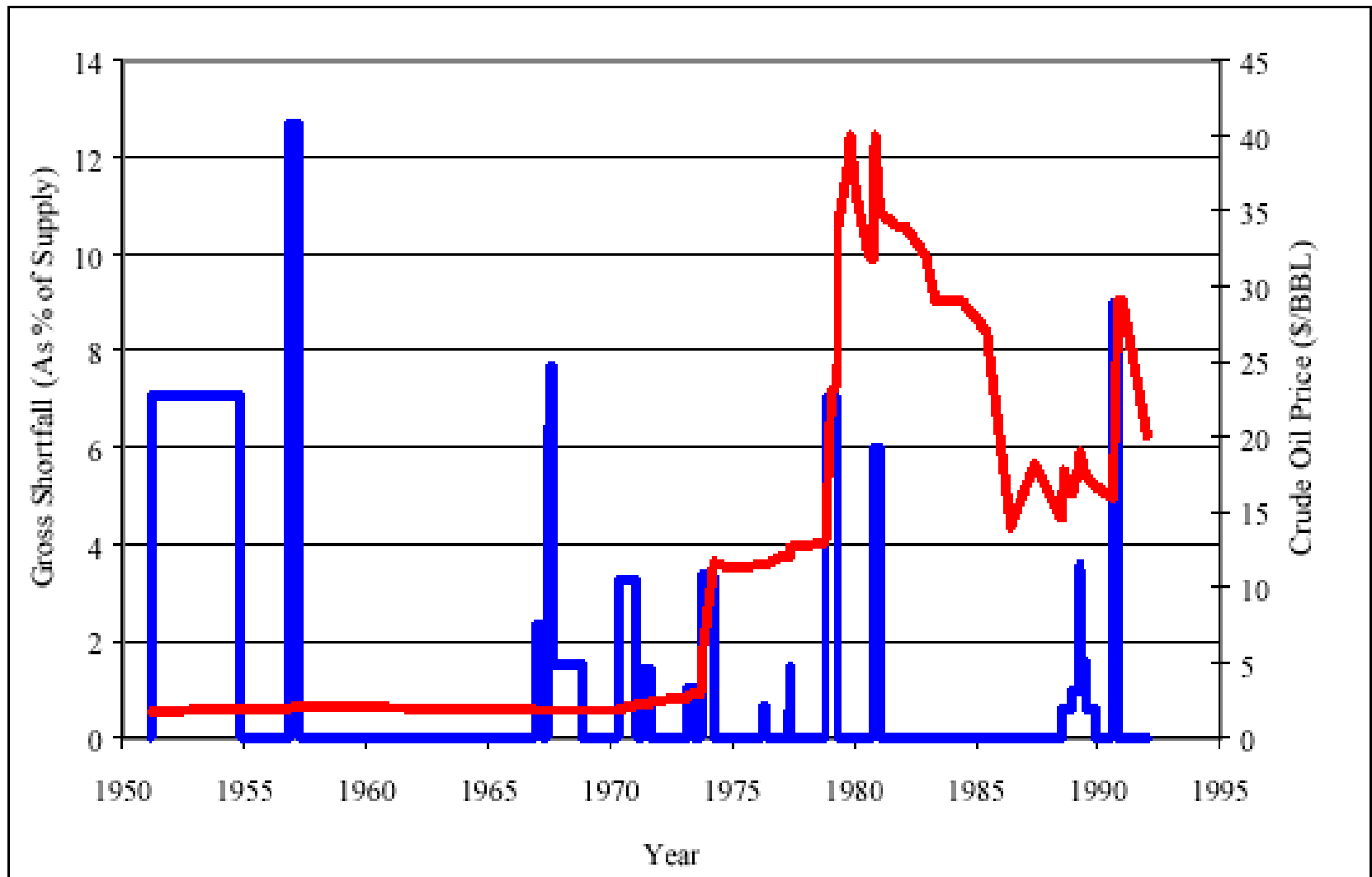
www.wtrg.com  
(479) 293-4081

— U.S. 1st Purchase Price ( Wellhead ) — "World Price" ^  
 — Avg U.S. \$26.64 — Avg World \$28.68 — Median U.S. & World \$19.60



# Sketch of a World Oil Pricing Model





**Figure 7:** Historical Disruptions. Not all Oil Supply Shocks Translate into Oil Price Shocks.

# Oil Tanker



**Table 1: Disruption Probabilities:  
Annual Probability of Gross Disruption as a Percent of World Supply**

<b>Case</b>	<b>Disruption of 10% or More of Supply</b>	<b>Disruption of 15% or More of Supply</b>
CIA 1999	1.1%	0.4%
DOE 1990 Lower Risk	1.5%	0.5%
DOE 1990 Midease	2.4%	1.0%
DOE 1990 Higher Risk	3.1%	1.4%
EMF 1996	5.3%	2.5%

# Example Probability Assessments

## 5. Saudi Shortfall

Conflict:

Neutral

Big Iran/Iraq

Saudi Factors:

SQ      Internal  
          Prob      Intent.  
                      Reductn

SQ      Internal  
          Prob      Intent.  
                      Reductn

**None**    **(0%)**

0.97	0.80	0.85
------	------	------

0.98	0.75	0.85
------	------	------

**Small**   **(33%)**

0.02	0.15	0.15
------	------	------

0.01	0.20	0.15
------	------	------

**Large**    **(75%)**

0.01	0.04	0
------	------	---

0.01	0.04	0
------	------	---

**All**        **(100%)**

0	0.01	0
---	------	---

0	0.01	0
---	------	---

Conflict:

Big Player

Other Major

Saudi Factors:

SQ      Internal  
          Prob      Intent.  
                      Reductn

SQ      Internal  
          Prob      Intent.  
                      Reductn

**None**    **(0%)**

0.20	0.10	0.95
------	------	------

0.97	0.78	0.85
------	------	------

**Small**   **(33%)**

0.60	0.40	0.03
------	------	------

0.02	0.17	0.15
------	------	------

**Large**    **(75%)**

0.15	0.30	0.02
------	------	------

0.01	0.04	0
------	------	---

**All**        **(100%)**

0.05	0.20	0
------	------	---

0	0.01	0
---	------	---

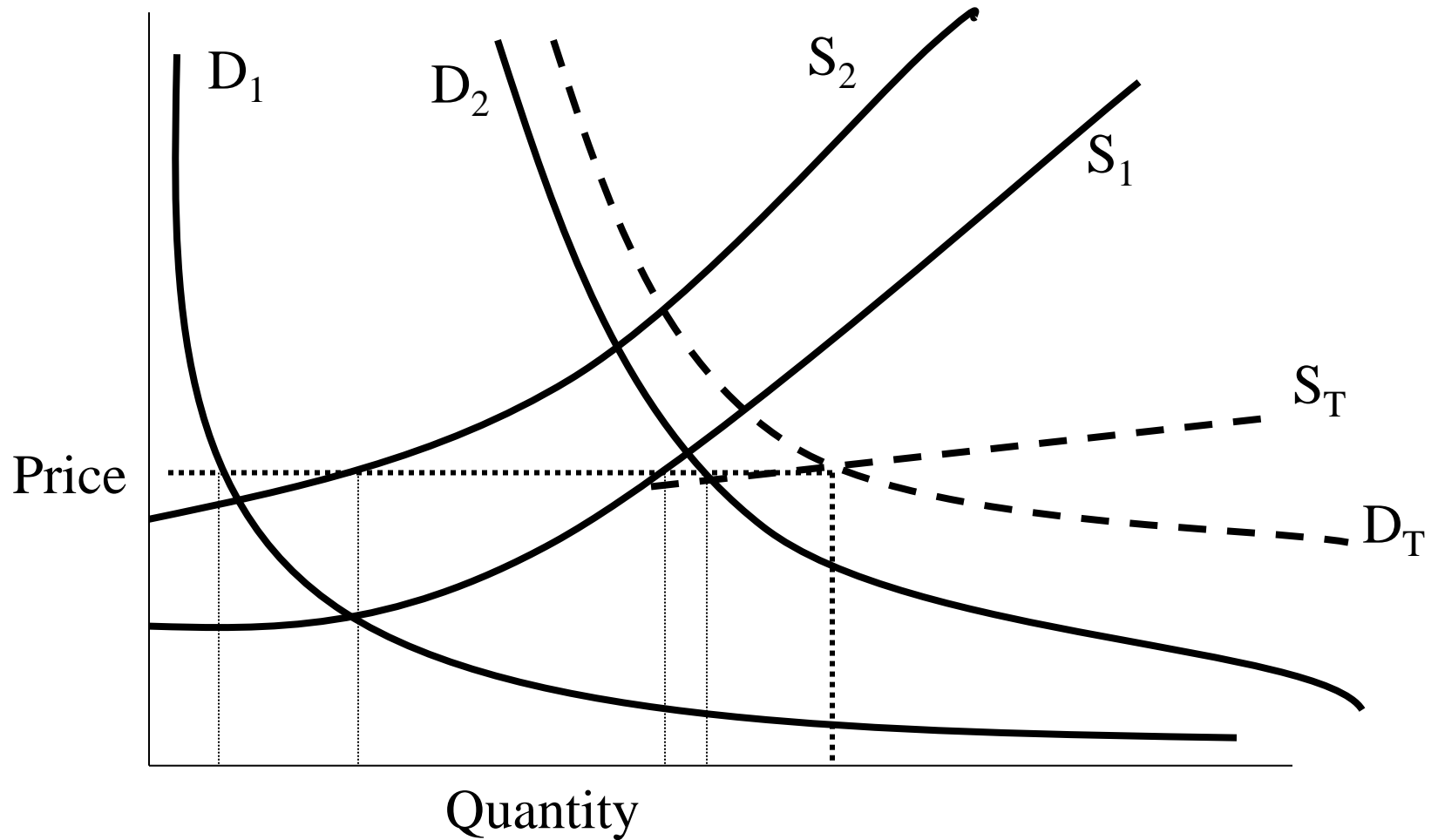
**Table 4: Summary of Oil Stockpiling Information**

<b>Characteristic \ Facility</b>	<b>Fill Current Capacity</b>	<b>Additions to Bayou Choctaw Capacity</b>	<b>Additions to Big Hill Capacity</b>	<b>New Facility</b>
Storage Capacity (MMB)*	120	20	80	200
Drawdown Capacity (MBD)*	315	35	350	1200
Years to Build*	0	4	8	11
Years to Fill	5	5	5	5
Capital Costs (Billions \$96)*	0.000	0.026	0.267	0.938
Capital Costs (\$96/BBL)	0.00	1.30	3.33	4.69
O&M Costs (\$96/BBL-Yr)**	0.17	0.17	0.17	0.17
Draw Costs (\$96/BBL)**	0.10	0.10	0.10	0.10
Fill Costs (\$96/BBL)**	0.09	0.09	0.09	0.09

\* PB-KBB (1999) Conceptual Design for 300 MMB SPR Site Expansion, Final Draft, April 19.

\*\* PB-KBB (1998) Strategic Oil Storage Concepts and Costs for Asia Pacific Region, Final Draft, October 30.

# Supply/Demand Equilibrium In Oil Market: The Two Country Case

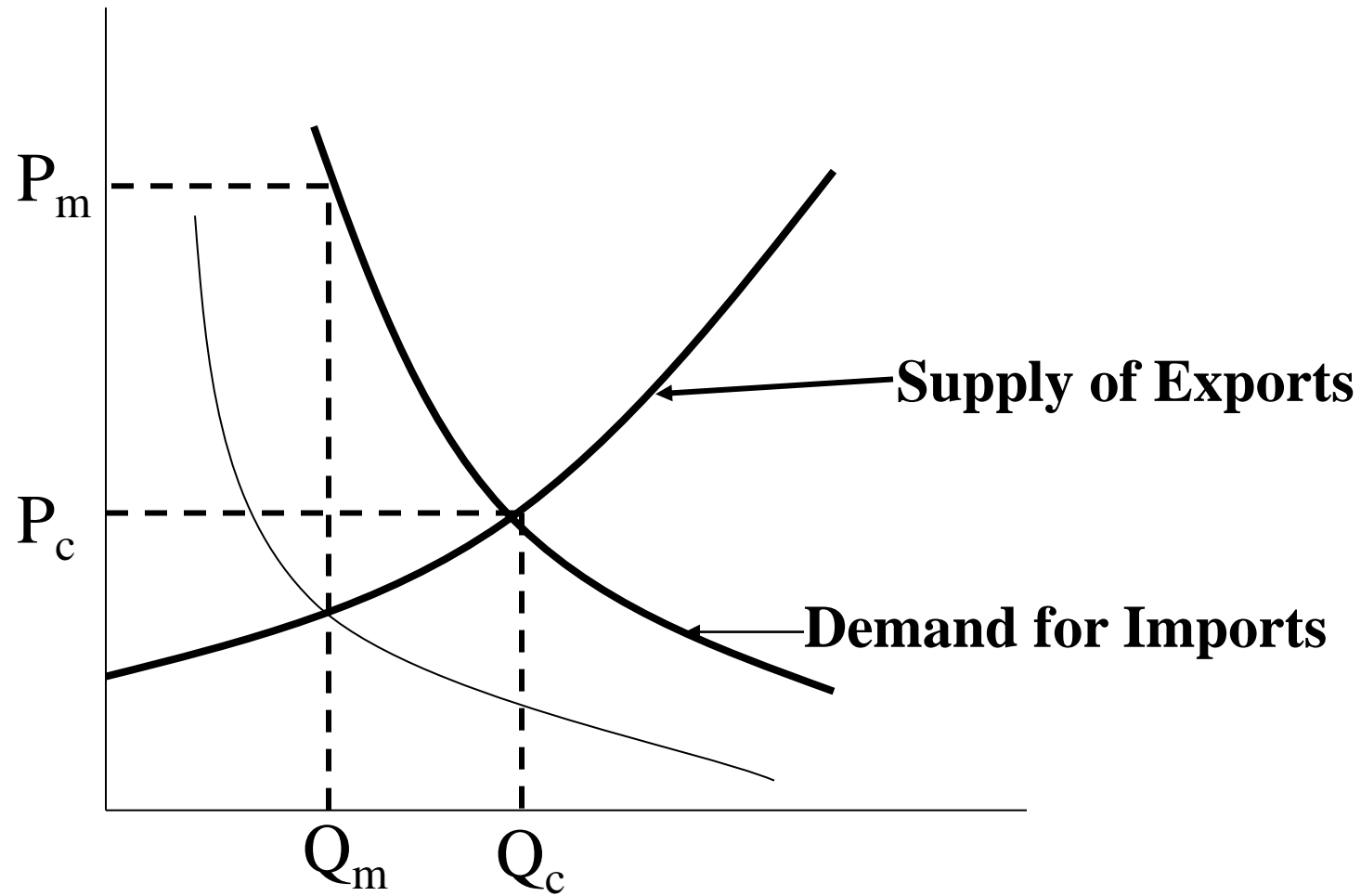


# Results of 1981 Roper Public Opinion Poll

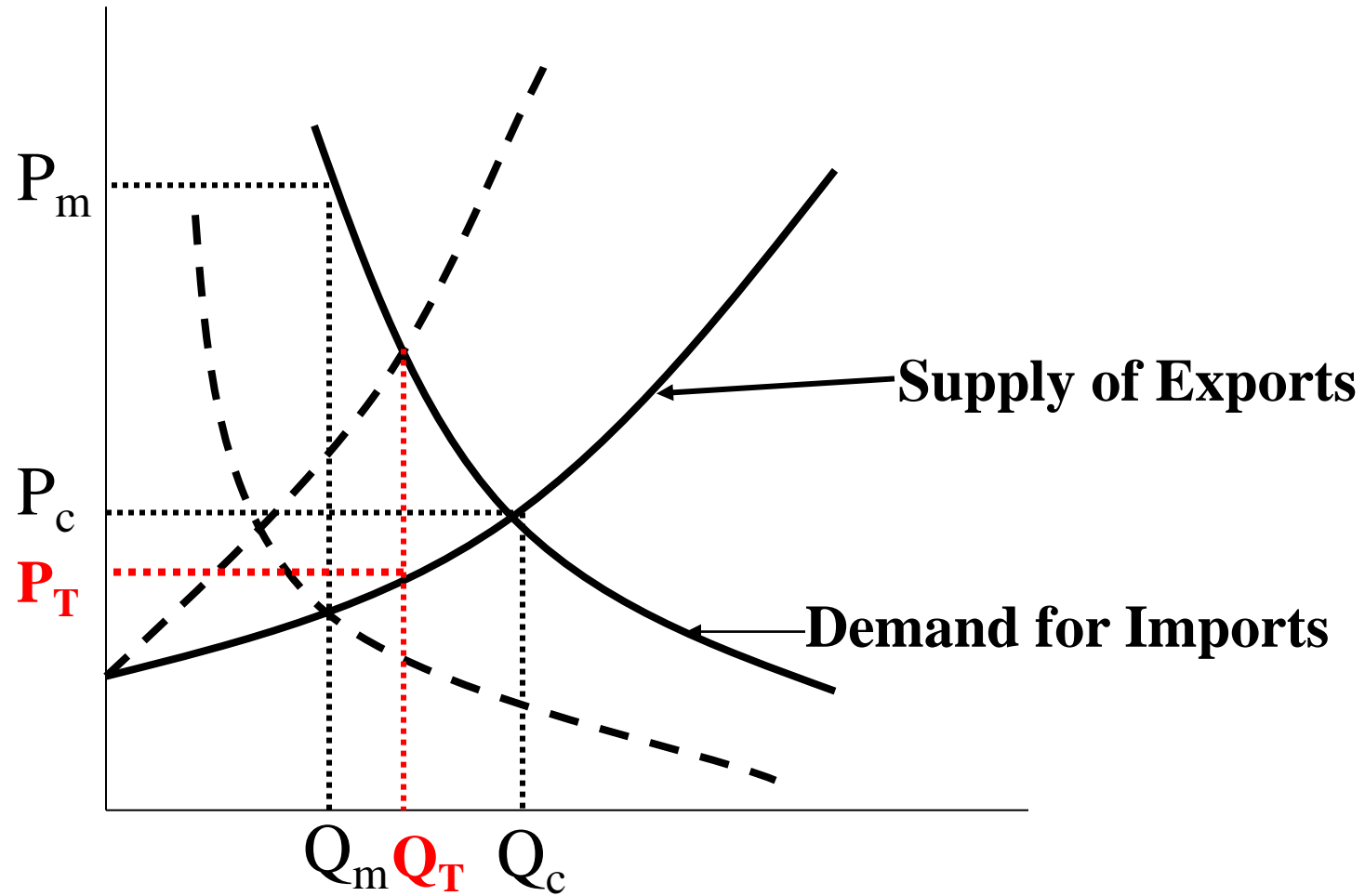
- Does the United States Import a Significant Amount of the Oil It Consumes?
  - 50% Said Yes
  - 50% Said No
- If it Does Import A Significant Amount of Oil, Has This Ever Caused Any Problems?
  - 50% Said Yes
  - 50% Said No



# Monopoly Pricing for Oil Exports



# Oil Import Tariff



# Computation of Net Benefits

**Expected NPV (Net Benefits) =**

- Expected NPV (Avoided GDP Loss)**
- + Expected NPV (Avoided Imports Cost Increase)**
- + Expected NPV (Avoided Net Surplus Loss)**
- Expected NPV (Reserve Net Oil and O&M Costs)**
- NPV (Facility Capital Costs)**

# Preventive Defense (Perry): Top Three Challenges Plus One

- International Terrorism
- Russian Resource Grab
- Chinese Resource Grab
- A Hybrid Tom Clancy Scenario in  
“The Bear and the Dragon”

# Issues With Fuel Substitution Strategies

- Natural Gas
  - Some Diversification Possible, But Majority of Reserves in Middle East and Russia
  - Some Air Pollution and Climate Change Concerns'
  - Expansion May Increase Terrorism Concerns
- Coal
  - More Diversification Possible, But Majority of Reserves in US, Russia and China
  - Major Air Pollution and Climate Change Concerns
- Nuclear
  - Proliferation and Terrorism Concerns

# Strategic World Oil Balance (2030)

IEA2008

Millions of Barrels Per Day

\$100/bbl Oil

<b>Oil Production</b>	<b>Oil Consumption</b>	<b>Imports(+)/ Exports (-)</b>	<b>Country/Region</b>
8.4	19	10.6	U.S.
5.1	13.9	8.8	EU
0	5.9	5.9	Japan
7.5	4.1	-3.4	OOECD
		0	
16.6	5.9	-10.7	Econ. in Transition
		0	
37.9	10.5	-27.4	Middle East
15	3.2	-11.8	Other OPEC
		0	
4.1	16.6	12.5	China
0.5	7.1	6.6	India
10.9	19.8	8.9	Other Dev. Countries
106	106	0	TOTAL

# Basic Components of the Oil Industry

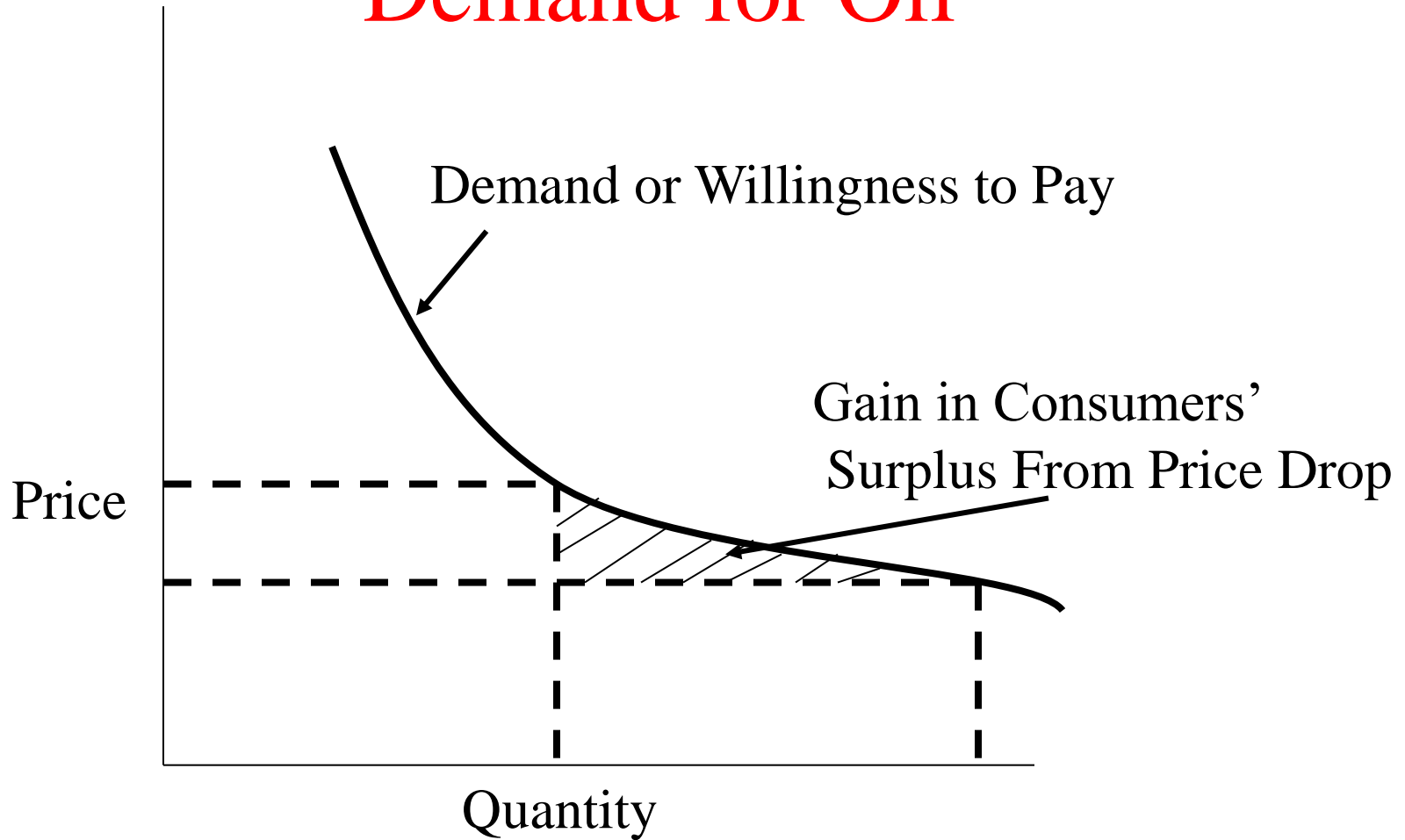
- Oil Wells
  - On-Shore
  - Off-Shore
- Oil Pipelines
- Oil Tankers
- Oil Refineries
- Oil Tank Farms
- Product Distribution
  - Railroad Oil Tanker Cars
  - Oil Tanker Trucks
- Gasoline Service Stations

# An Oil Tanker





# Demand for Oil



# Supply of Oil

