UNIVERSITY OF PATRAS DEPARTMENT OF ECONOMICS

ENERGY ECONOMICS

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Lecture 9th
Energy access and security

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Energy Economics-Energy security and access

- Energy policy varies between different countries, reflecting the political but social concern for rational use of energy while technological innovation in the energy sector is often referred to as a solution.

- The first concerns about energy security emerged for the first time in the wake of the first oil crisis in the 1970s (creation of OPEC) when several countries had to struggle to cope with the negative effects of oil price rises and high fluctuations (creation of IEA). Since then, countries have pursued different policies to reduce the problem.

- However, the low oil prices since the mid-1980s and the shift in the center of gravity in the 1990s to reforming and restructuring the oil market have avoided attention to security of supply as several analysts considered the markets to be position to solve the problems of the energy sector.

- However, modern concerns about the peak of oil supply and supply capacity to match demand have been brought back to the times of steadily high oil prices and fluctuations in oil prices. Once again, the issue of energy security has become a major political issue.
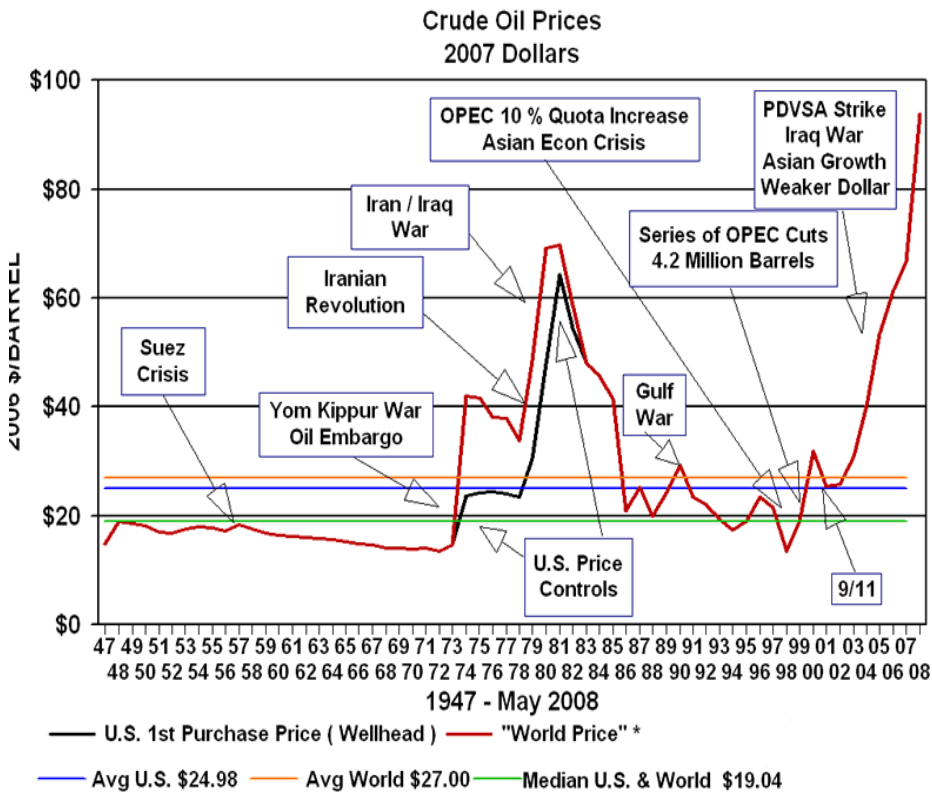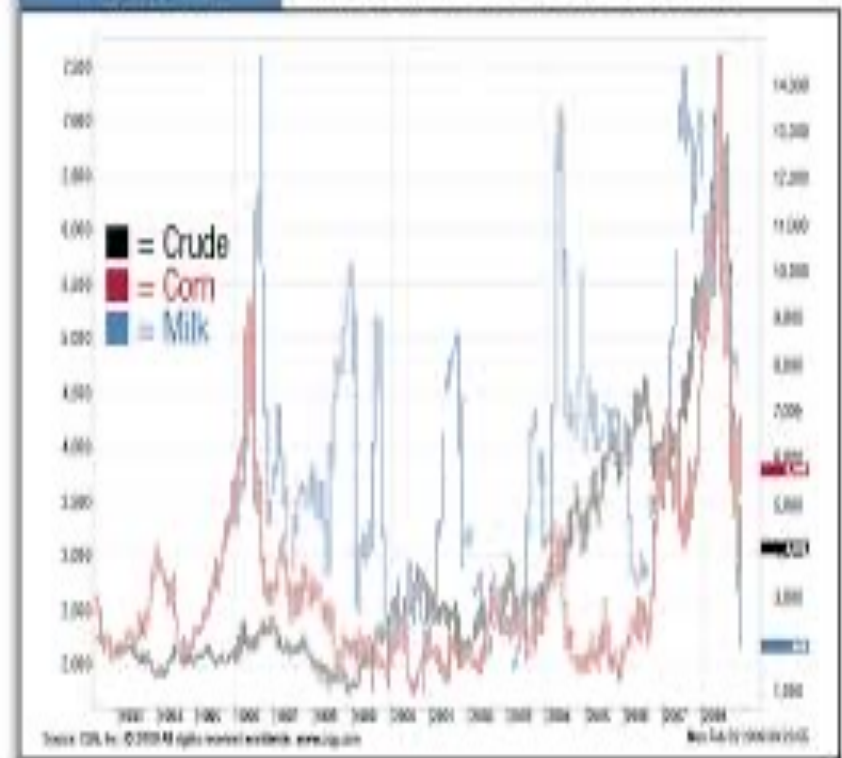
Look at Graphs

Crude Oil Prices
2007 Dollars

OPEC 10 % Quota Increase
Asian Econ Crisis

PDVSA Strike
Iraq War
Asian Growth
Weaker Dollar

Iran / Iraq War

Series of OPEC Cuts
4.2 Million Barrels

Iranian Revolution

Suez Crisis

Gulf War

Yom Kippur War Oil Embargo

U.S. Price Controls

9/11

1947 - May 2008

U.S. 1st Purchase Price (Wellhead)   "World Price" *

Avg U.S. $24.98   Avg World $27.00   Median U.S. & World $19.04

Figure 2   Milk, corn and crude 15-year history

■ = Crude
■ = Corn
■ = Milk

Today ….

- There is increasing concentration on the supply side.
  Since 1970, many of the oil extraction fields outside the Middle
  Of the East have matured.

- In 1970, about half of the stocks oil is located in the Middle East,
  while in 2006 it was around two thirds.

- The maturity of many of the older fields implies that the
  providing easily accessible conventional oil sources are located
  in a declining way and in combination with climate change, will have
  impact on how the energy crisis will intensify.

- The emergence of natural gas since the 1970s has led in a further
  concentration. Today, natural gas resources are concentrated in three
  countries: Russia, Iran and Qatar. In addition, Russia, a new key
  player on its side is increasingly affecting OPEC and is playing
  a strong role in the gas market.

Oil reserves I

Oil reserves II

Today…

Total demand has increased by 50% and demand for natural gas has increased even more than 150%.
Today it is hard to believe that it was a shock to Qatar when it discovered gas instead of the expected oil in the 1980s.
Energy markets have seen waves of liberalization and globalization since the 1970's becoming more interconnected. Critical infrastructure - pipelines, refineries, transmission and distribution networks, nuclear power plants seem to reach maturity. Oil prices, in particular, and energy prices in general have reached their highest levels since oil crises, while the situation is further exacerbated by high levels of volatility (until a few months ago). Uncertainty and high prices rekindled economic nationalism and protectionism (Venezuela, Bolivia, Russia, as well as in Europe and the US).

Natural gas reserves
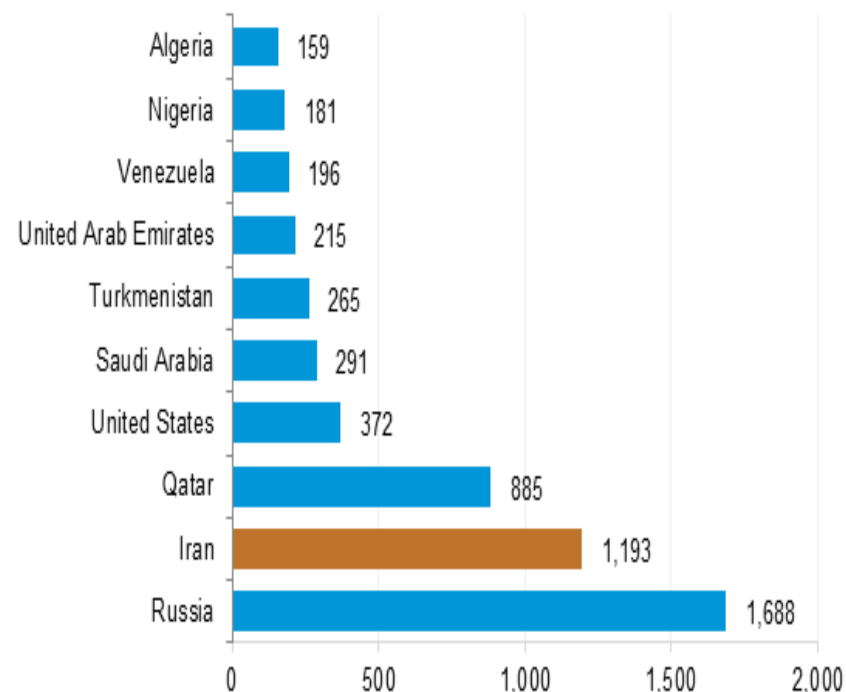

Largest proven natural gas reserves holders
trillion cubic feet
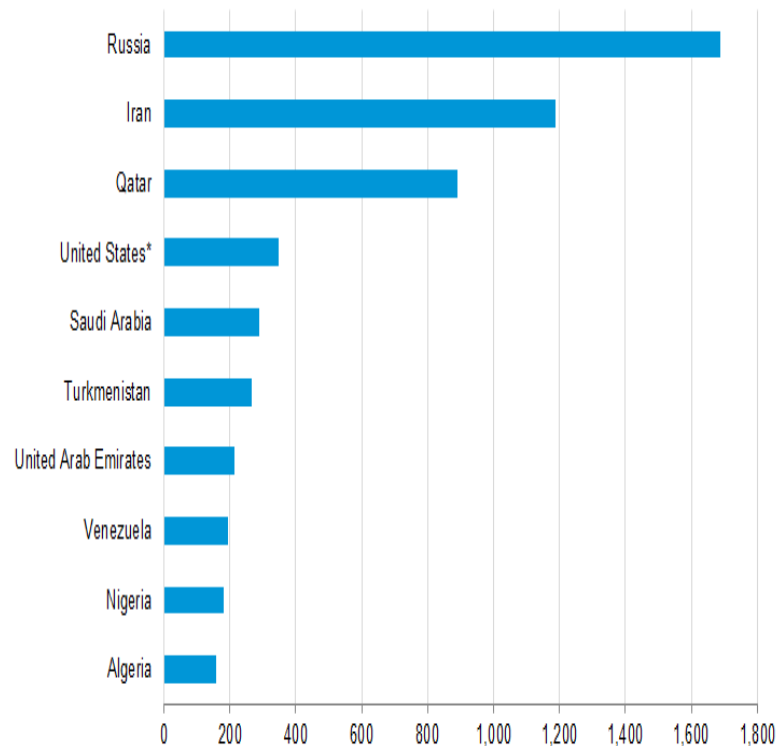
Note: The United States reserves are wet gas reserves as of December 2011
Source: United States: U.S. Energy Information Administration; Other Countries: Oil and Gas Journal 2013

Largest proved reserve holders of natural gas, January 2014
trillion cubic feet

Country	Value
Algeria	159
Nigeria	181
Venezuela	196
United Arab Emirates	215
Turkmenistan	265
Saudi Arabia	291
United States	372
Qatar	885
Iran	1,193
Russia	1,688

Source: Oil & Gas Journal

Definition

- The concept of energy security is inextricably linked with that of energy independence (Bordoff et al., 2010 ch7) but is defined as the reliable and sufficient supply of any form of energy at reasonable prices (Bielecki, 2002).

- What, however, is considered reliable and what are the prices considered "reasonable"?

Energy security for oil

The literature focuses on its safe oil supply in particular and identifies a number components of the energy security problem (Toman, 2002):

(a) the exercise of market power by suppliers to raise prices,

(b) macroeconomic imbalances due to energy price volatility,

(c) threats to infrastructure, local dangers of reliability; and

(d) environmental safety.

Relationship between climate change and energy dependence I

Choosing lignite or coal obviously as a means dependence on oil creates issues increase in emissions of gaseous pollutants. On the other the choice of nuclear energy is significant risks. Since a large number of t options are available to try to reduce them greenhouse gas emissions with different opportunities for enhancing energy security, there is space for a trade-off.

Relationship between climate change and energy dependence II

Energy security enhancement

Strategic Petroleum Reserves

Two key policy objectives are represented: enhancing energy security and reducing greenhouse gas emissions to protect the climate. However, there are a number of alternatives, Strategic Oil Reserves (SPR) or corn-based ethanol, nuclear use, RES use, etc.).

Nuclear / Renewable options
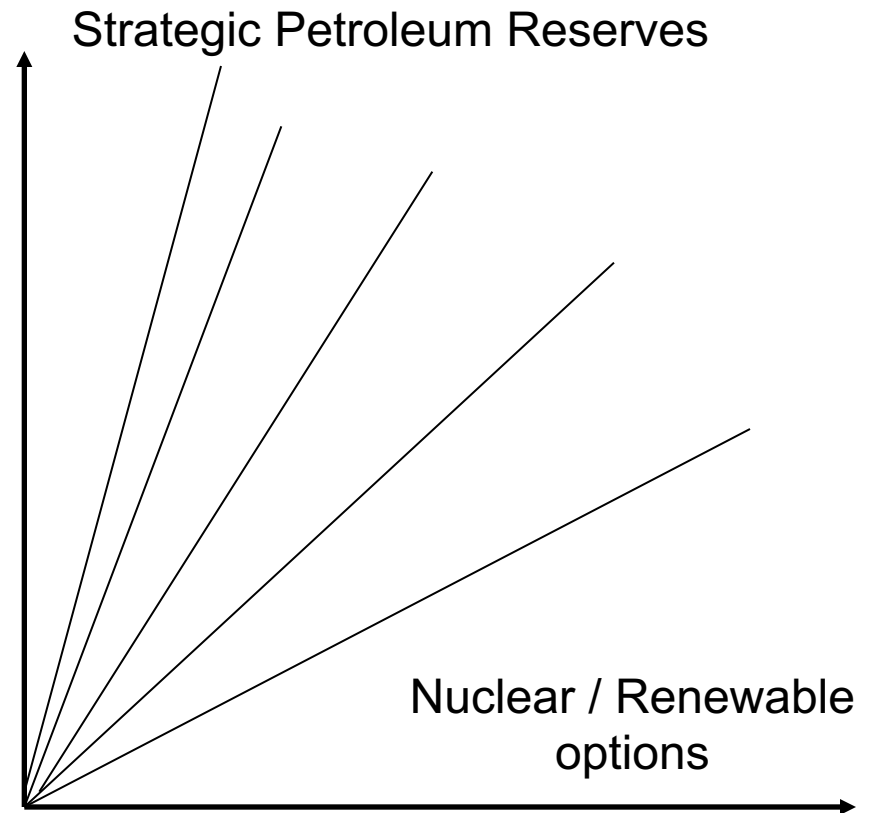
GHG reduction

Relationship between climate change and energy dependence III

c_i cost, $x_1, ..., x_n$ tech

S security

$$S = \sum_{i=1}^{n} s_i(x_i)$$

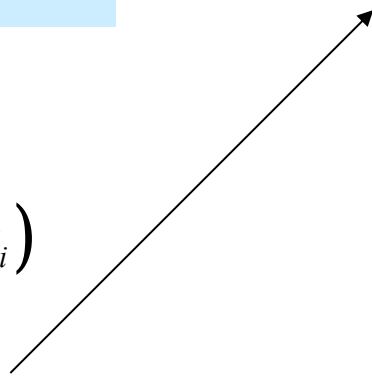Total emission reduction is given at TC cost. So this is a minimization problem:

$$Q = \sum_{i=1}^{n} q_i(x_i), TC = \sum_{i=1}^{n} c_i(x_i)$$

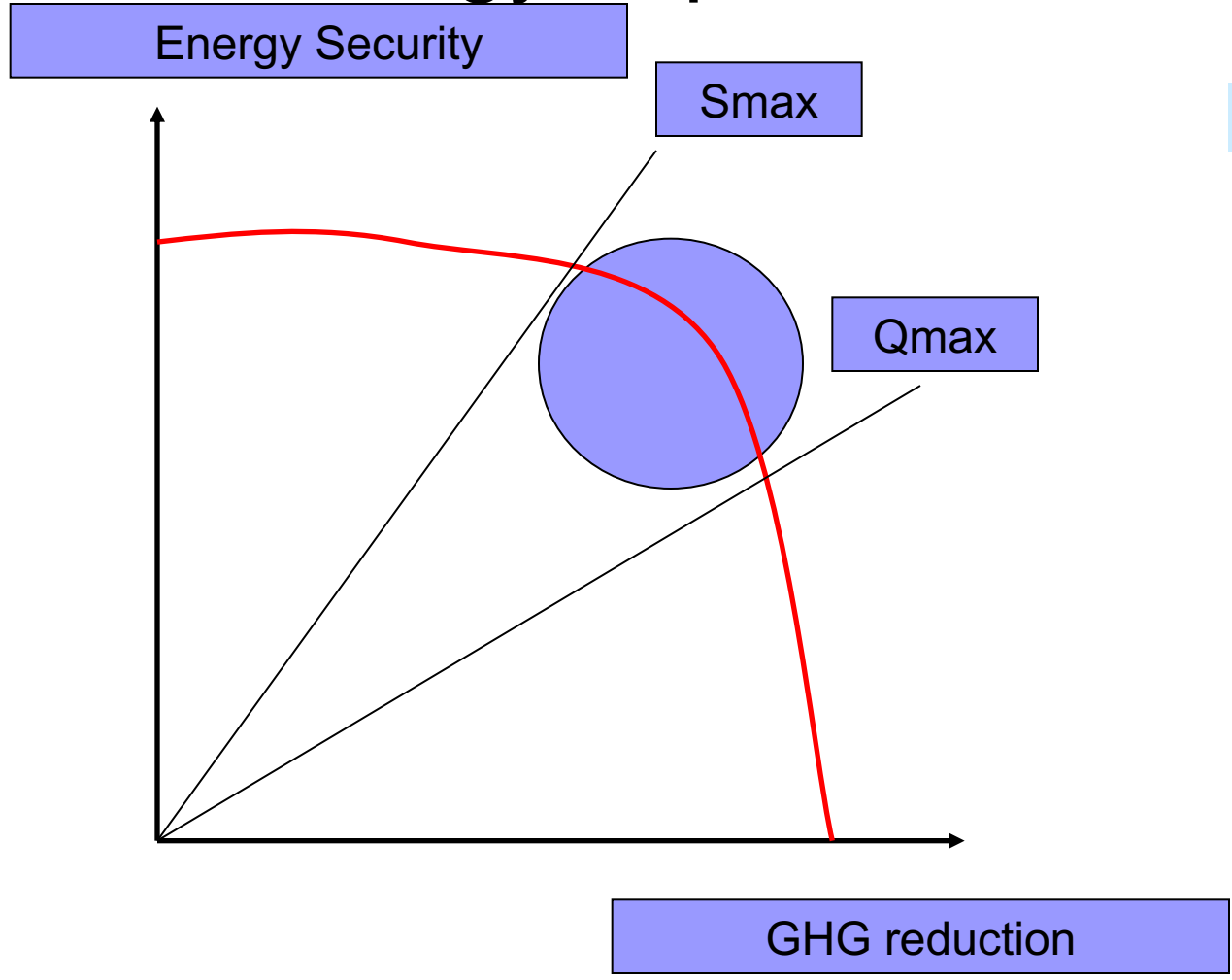$$L = TC - l_s \sum_{i=1}^{n} s_i(x_i) - l_Q \sum_{i=1}^{n} q_i(x_i)$$

$$\frac{\partial TC}{\partial x_i} = l_s \frac{\partial s_i}{\partial x_i} + l_Q \frac{\partial q_i}{\partial x_i}$$

$$\frac{\partial TC}{\partial s_i} = l_s$$

$$\frac{\partial TC}{\partial q_i} = l_q$$

Relationship between climate change and energy dependence IV

Energy Security

Smax

Differentiation

Qmax

$$\frac{\partial TC}{\partial s_i} = l_s$$

$$\frac{\partial TC}{\partial q_i} = l_q$$

GHG reduction

Can we measure energy security?(1)

- Energy Dependency Indicator: It can be used to reflect the overall energy supply situation of a country or region. For example, if a country consumes 100 million primary energy TPI and 90 million MTF is imported, dependence on imports is 90%. High import dependence tends to increase the price risk and the volume risk related to interruption. However, it may also concern a type of fuel and significant variation by species.

Δείκτες

- Ενεργειακή εξάρτηση *συνολική* και *ανά καύσιμο*(%)
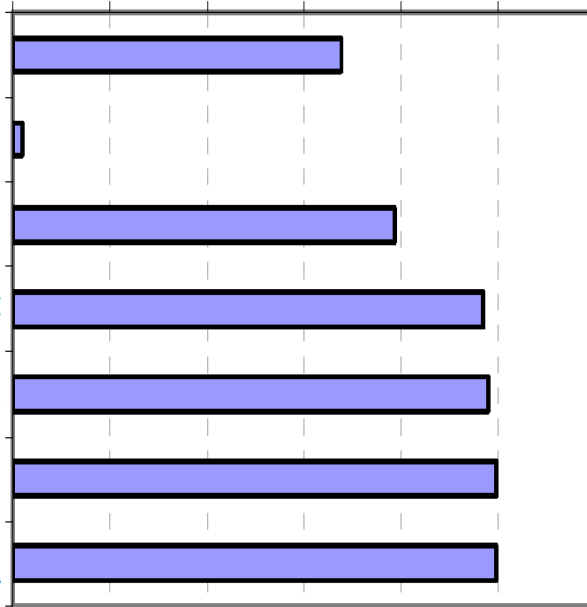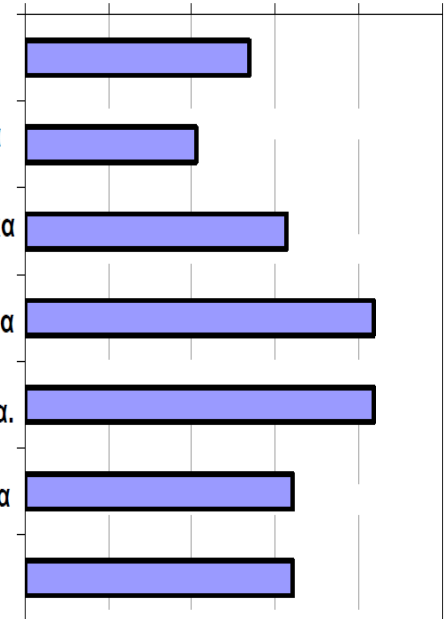
Δείκτες

Ενεργειακή εξάρτηση (σε %) – Εξέλιξη μεταξύ 1990 και 2009
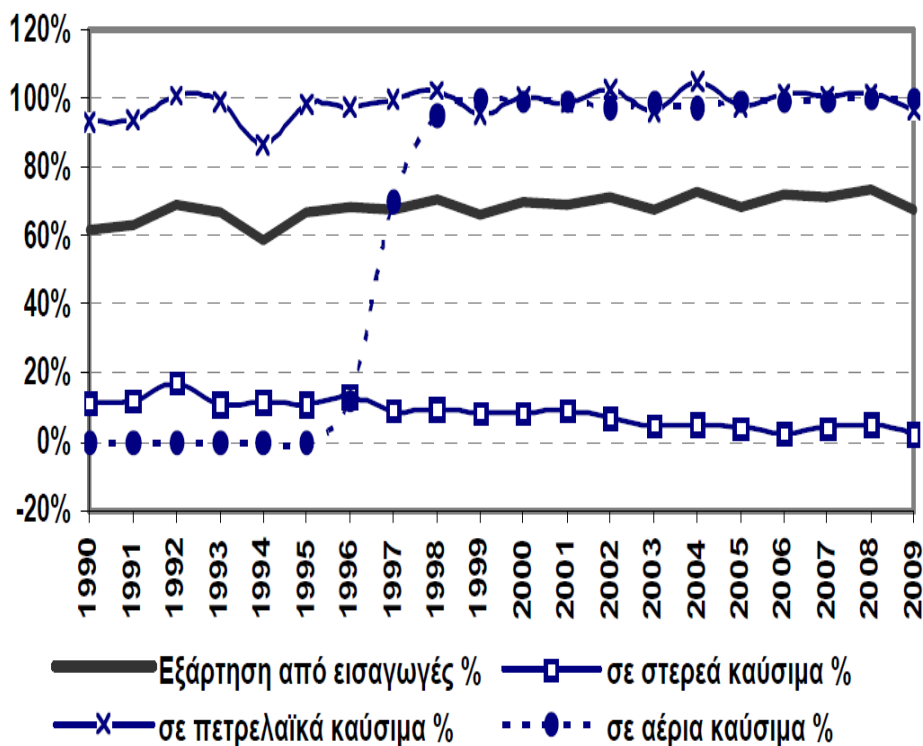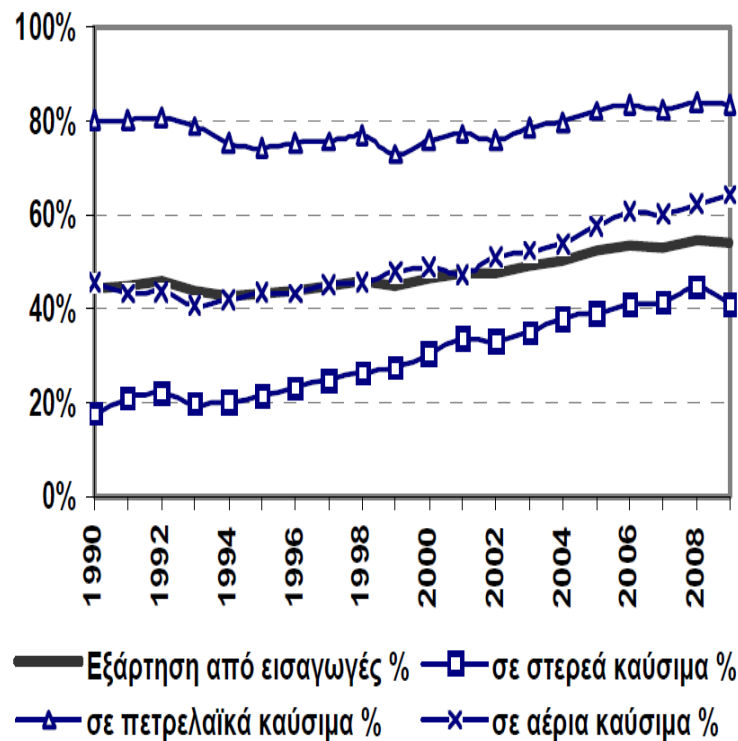
Can we measure energy security? (2)

- Fuel mix: The benchmark indicates the share of a particular fuel in the country's energy demand or its importance in energy supply. Depending on the focus of the analysis, this ratio can be set at different levels:

Can we measure energy security? (3)

(a) The primary mix of energy consumption shows how varied the total energy demand is. For example, if a country uses 90% of oil and petroleum products and 10% of natural gas to meet primary energy demand, it can not be said to have a diversified fuel mix.

(b) The final energy consumption mix gives an indication of fuel end-use fuel end-users.

(c) The sectoral fuel mix level provides a similar picture at end-use segment level. Expanding sectoral analysis provides a clearer picture of the diversity of the different sectors. For example, if the industry only relies on electricity and gas for its energy needs, and if electricity is dependent on gas supply, then industry is highly volatile on changes in gas supply.

(d) The electricity generation mix tells which fuels (and technologies) a country uses to supply electricity.

Can we measure energy security? (4) - Concentration and differentiation indicators

1) Herfindahl-Hirschman
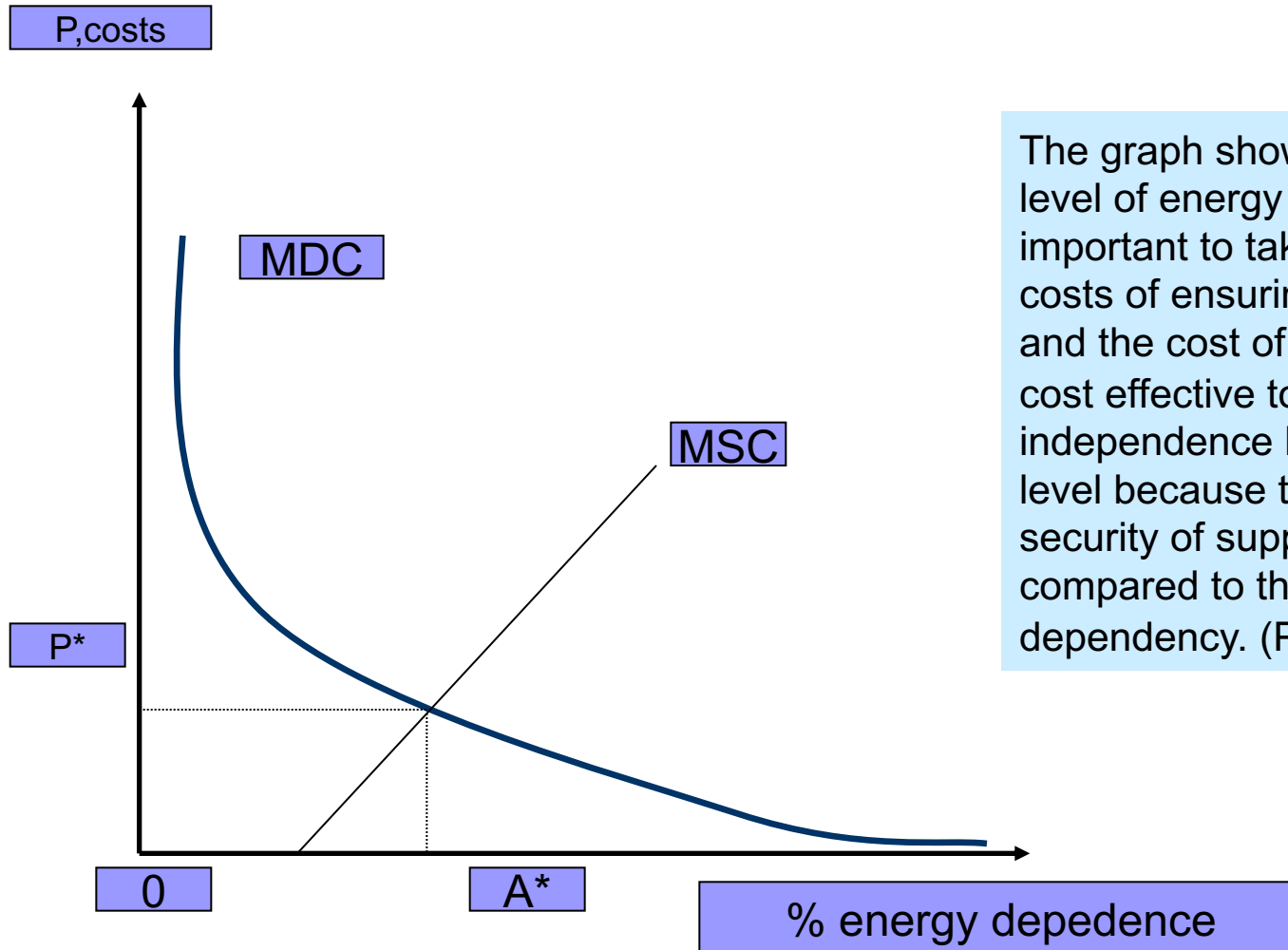
$$HHI = \sum_{i}^{N} x_i^2$$

2) Shannon-Wiener

$$SW = -\sum_{i}^{N} x_i \ln x_i$$

3) Shannon-Wiener-Neumann

$$SWN = -\sum_{i}^{N} b_i x_i \ln x_i \qquad SWN^* = -\sum_{i}^{N} \left(b_i x_i \ln x_i \right) \left(1 + g_i \right)$$

Is there an optimal level of energy dependency;

P,costs

MDC

MSC

P*

0

A*

% energy depedence

The graph shows that for an optimal level of energy independence, it is important to take into account the costs of ensuring security of supply and the cost of the damage. It is not cost effective to improve energy independence beyond the optimum level because the cost of providing security of supply will be much higher compared to the marginal cost of dependency. (Percebois, 1989)

Policies related to dependence on energy imports

- Import restrictions. For example, the tax effect on the import price.
- Diversification of imports
- Differentiating a fuel mix
- Improving energy efficiency.

Improving energy efficiency

Energy efficiency reduces energy demand; which in turn reduces the import requirement. This also reduces environmental damage and damage depletion of resources. Although important efforts have been directed towards improving it energy efficiency and management plans of demand, the tendency for available cheap energy has reduced.

Differentiating fuel mix

Differentiation of the fuel mix in an economy is trying to reduce dependence on a particular fuel and to succeed a diversified portfolio of energy options. For example, for the US, there has been an effort to diversify of the fuel mix for a long time so that it can be replaced oil and coal from natural gas and nuclear energy. This policy is often limited by: availability of resources, available technology options for capitalizing on these resources, costs and costs investment requirements, as well as other issues, such as environmental and social problems.

Diversification of imports I

It concerns the effort to diversify sources of supply. From Economically speaking, this means finding its solution offering minimal cost taking the risk of withdrawal from the supply side. However, for oil and in less for gas, global dependence on gas Middle East is expected to increase as most of the stocks are there. This in combination with politics instability of the region and rising demand from developing economies raise concerns about its future security of supply.

Diversification of imports II

Two new developments in the field of
diversification of imports may be worth mentioning.

- The former is related to an increased level of activities and investment in production facilities from importing countries to overseas oil producing regions.

- A second trend seems to emerge in the form of seeking cooperative solutions instead of relying on competitive results.

Import restrictions

P

P1

P2+t

P2

Q3   Q5   Q4   Q2

Q

P

ID

IDt

Qt   Q1

Q
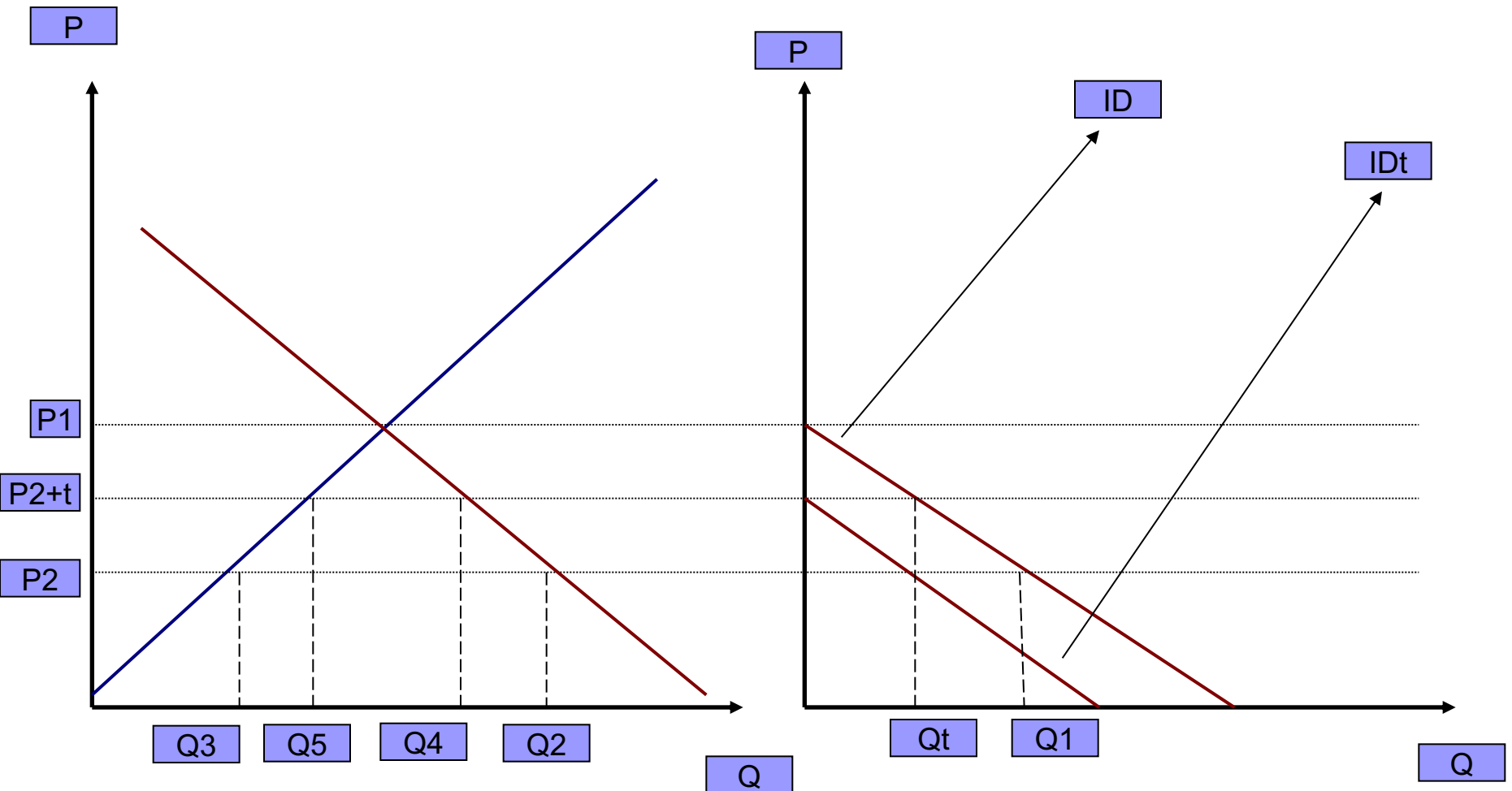
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