

Empirical Look at Global Efficiencies

Ajay Gupta 2009

Empirical Problem

- Efficiency is improved by increasing penetration of market economies and/or technology.
- Economic Efficiency = maximize net benefits
- Could find no real testable empirical evidence of this.

Efficiency

- Energy Efficiency = maximize output per unit input
- National BPE Efficiency* = $\text{GDP} / \text{Energy Consumption}$
- * as per this study

Data

- **GDP Data:** taken from World Bank Development Indicators Online. GDP constant 2000 US\$ (GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fab).
- **Energy Consumption Data:** taken by source from EIA, International Energy Annual 2005 and converted to Joules.

Efficiency As Defined in this Study

■ Non-Quality Corrected Efficiency:

- $NQCEfficiency = GDP / (DNG + Coal + Petro + Hydro + Nuclear + Other Electricity)$

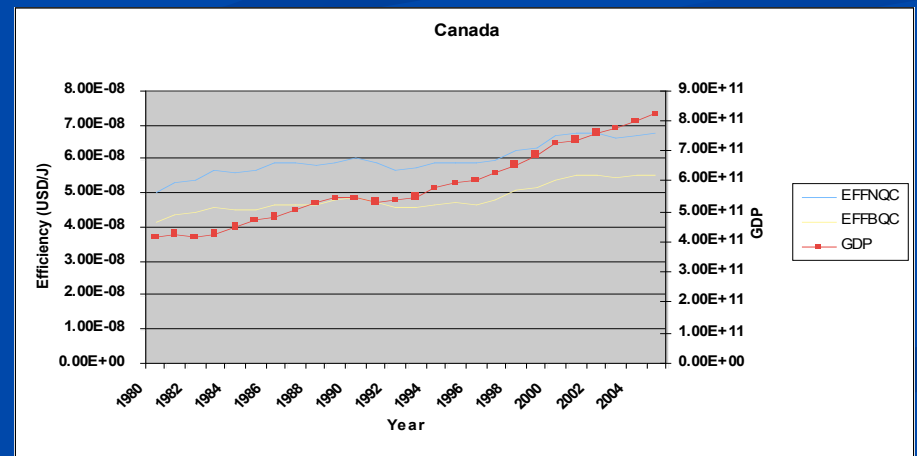
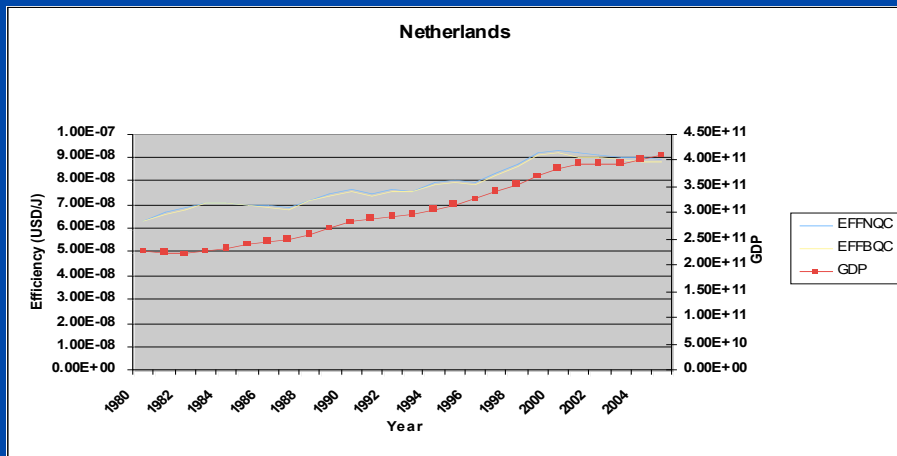
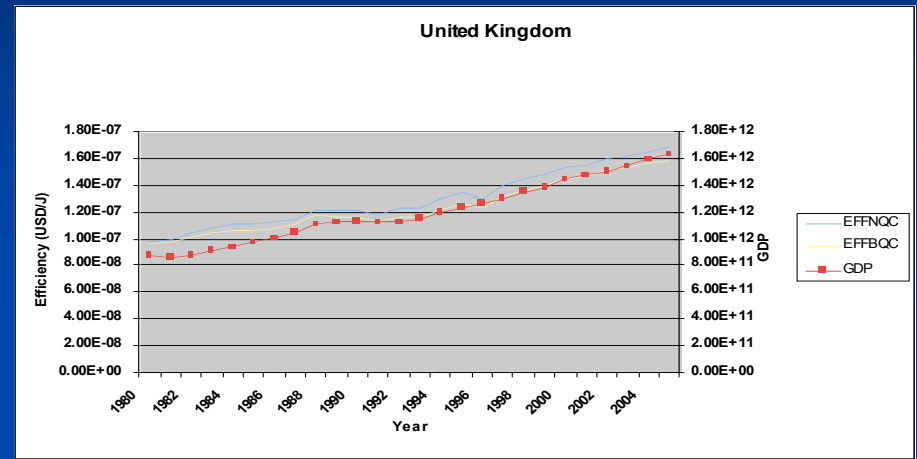
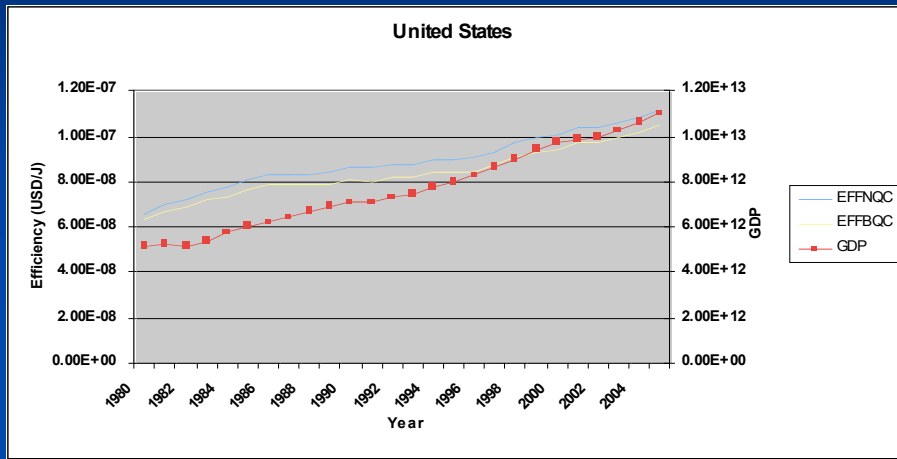
■ Basic Quality Corrected Efficiency:

- $BQCEfficiency = GDP / (DNG + Coal + Petro + 2.63 * (Hydro + Nuclear + Other Electricity))$

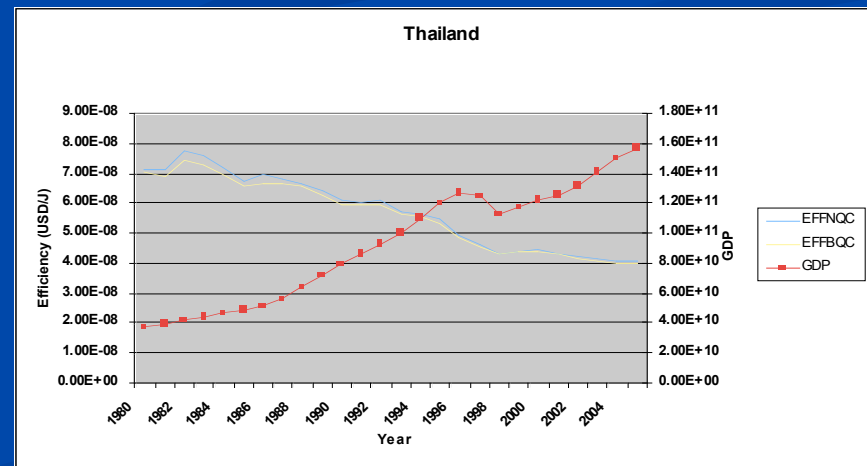
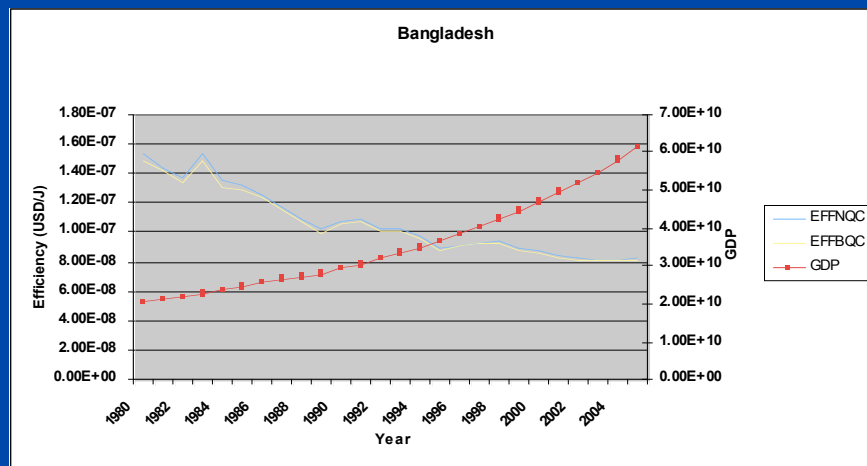
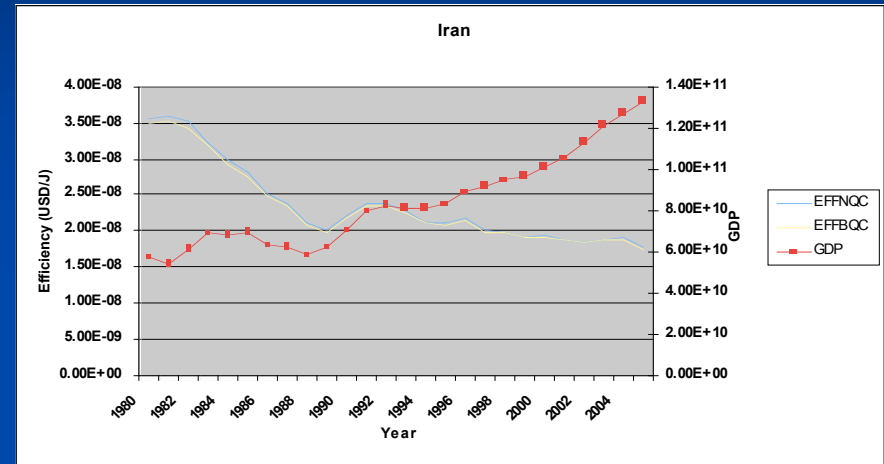
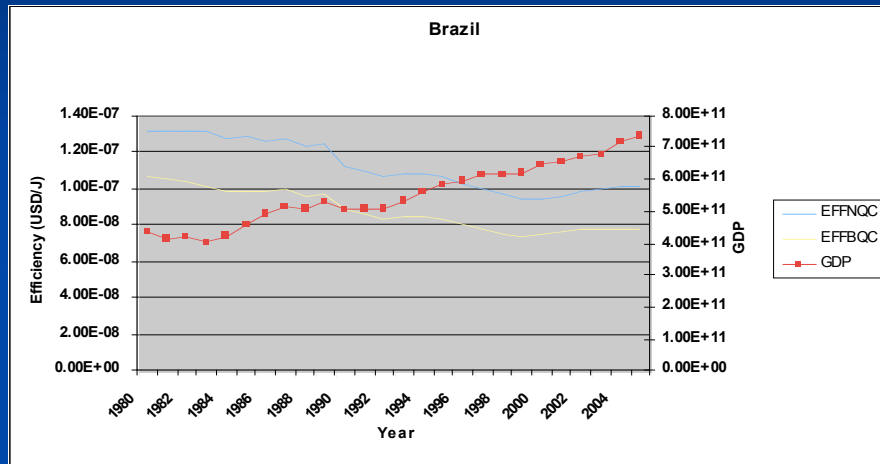
- Electricity values were multiplied by 2.63, from Nilsson, L. J. (1993): *Energy intensity trends in 31 industrial and developing countries 1950-1988*. In: *Energy* 18(4), pp. 309-322.

- Time Frame for Calculations is from 1980 to 2005 (limited by gaps in available data)

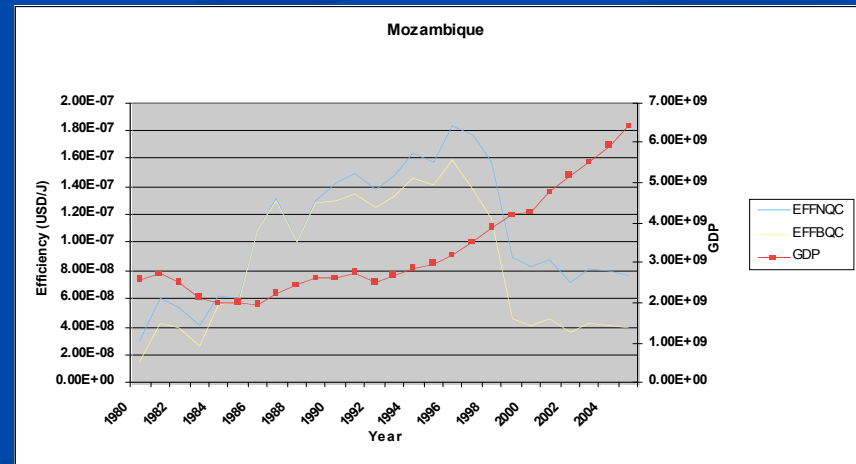
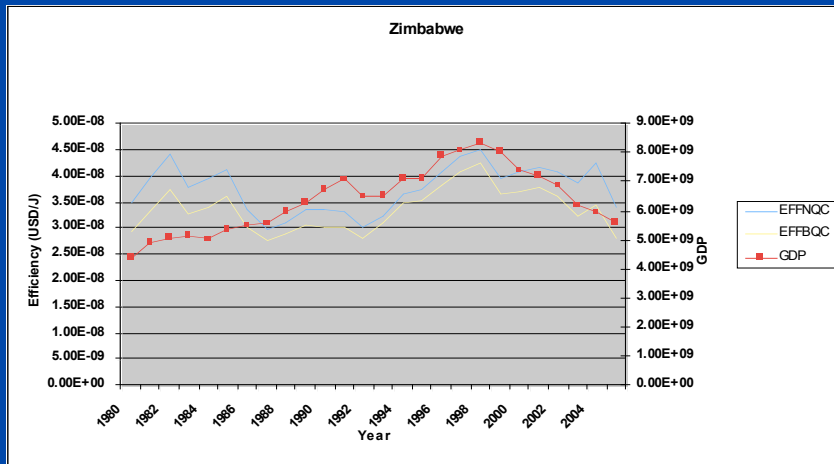
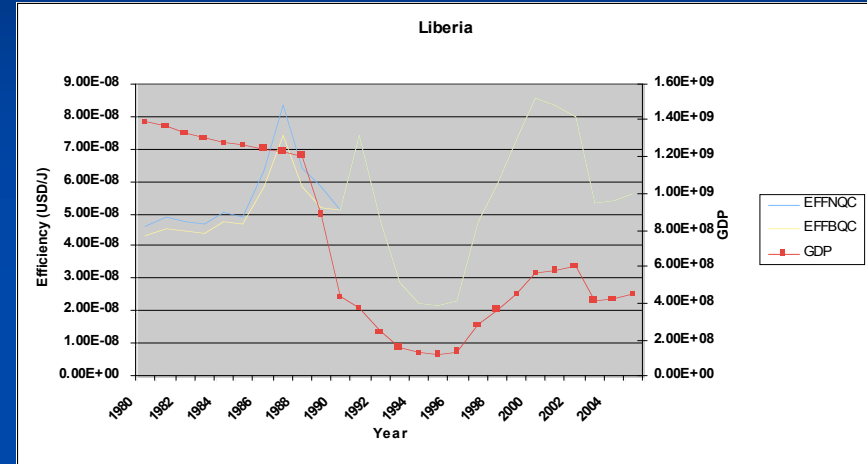
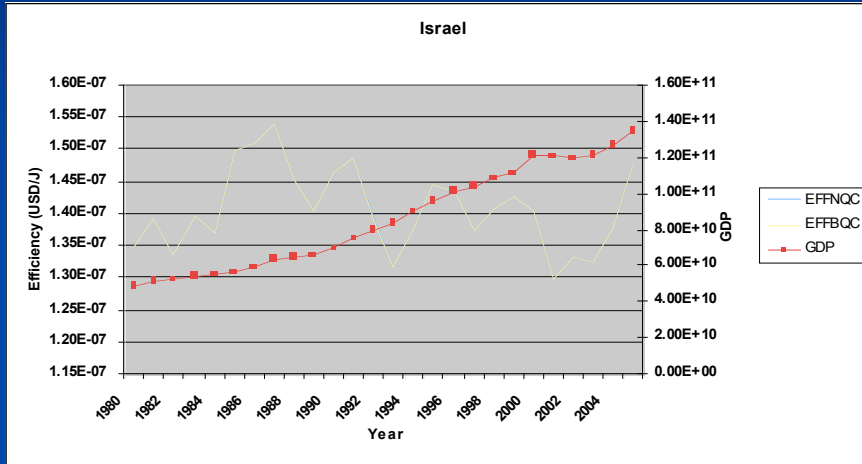
Countries with Increasing Efficiencies



Countries with Decreasing Efficiencies



Countries with Erratic Efficiencies



Breakdown by Trend*

- Increasing Efficiency: **35** countries
 - Canada, US, France, Sweden, Netherlands, UK...
- Decreasing Efficiency: **39** countries
 - Bolivia, El Salvador, Portugal, Iran...
- Flat Efficiency: **21** countries
- Other Efficiency Trend: **33** countries

■ * Trends established visually

Efficiency Trends			
Increasing	Decreasing	Flat	Other
Canada	Bolivia	Mexico	Argentina
United States	Brazil	Chile	Belize
Antigua and Barbuda	Dominica	Costa Rica	Guyana
Columbia	Dominican Republic	Ecuador	Jamaica
Panama	El Salvador	Cyprus	Saint Lucia
Peru	Grenada	Austria	Suriname
Saint Kitts and Nevis	Guatemala	Iceland	Uruguay
Albania	Haiti	Italy	Venezuela
Belgium	Honduras	Spain	Greece
Bulgaria	Nicaragua	Algeria	Luxembourg
Denmark	Paraguay	Egypt	Malta
Finland	Saint Vincent and Grenadines	The Gambia	Syria
France	Trinidad and Tobago	Ghana	Yemen
Hungary	Turkey	Morocco	Bahrain
Ireland	Portugal	South Africa	Israel
Netherlands	Iran	Tunisia	Burkina Faso
Norway	Jordan	Brunei	Cameroon
Romania	Oman	Hong Kong	Kenya
Sweden	Saudi Arabia	India	Lesotho
Switzerland	United Arab Emirates	Pakistan	Liberia
United Kingdom	Benin	Singapore	Malawi
Botswana	Burundi		Mozambique
Chad	Central African Republic		Niger
Congo (Kinshasa)	Comoros		Nigeria
Gabon	Congo (Brazzavile)		Senegal
Guinea	Ivory Coast		Sierra Leone
Mali	Guinea-Bissau		Sudan
Swaziland	Madagascar		Zimbabwe
Zambia	Mauritania		Kiribati
Australia	Mauritius		South Korea
China	Rwanda		New Zealand
Japan	Seychelles		Papua New Guinea
Solomon Islands	Togo		Philippines
Sri Lanka	Bangladesh		
Vanuatu	Bhutan		
	Indonesia		
	Malaysia		
	Nepal		
	Thailand		

20 Caribbean Countries

Island Countries

Antigua and Barbuda
Dominica
Dominican Republic
Grenada
Haiti
Jamaica
Puerto Rico
Saint Kitts and Nevis
Saint Lucia
Saint Vincent/Grenadines
Trinidad and Tobago

Mainland Countries

Belize
Colombia
Costa Rica
Guyana
Honduras
Mexico
Nicaragua
Panama
Venezuela

Efficacy

- Most politicians/economists want to grow the economy faster than the population. But how?
- One way for Caribbean countries is to invite the discretionary income of other countries.
- That requires cheap and abundant energy and discretionary income.

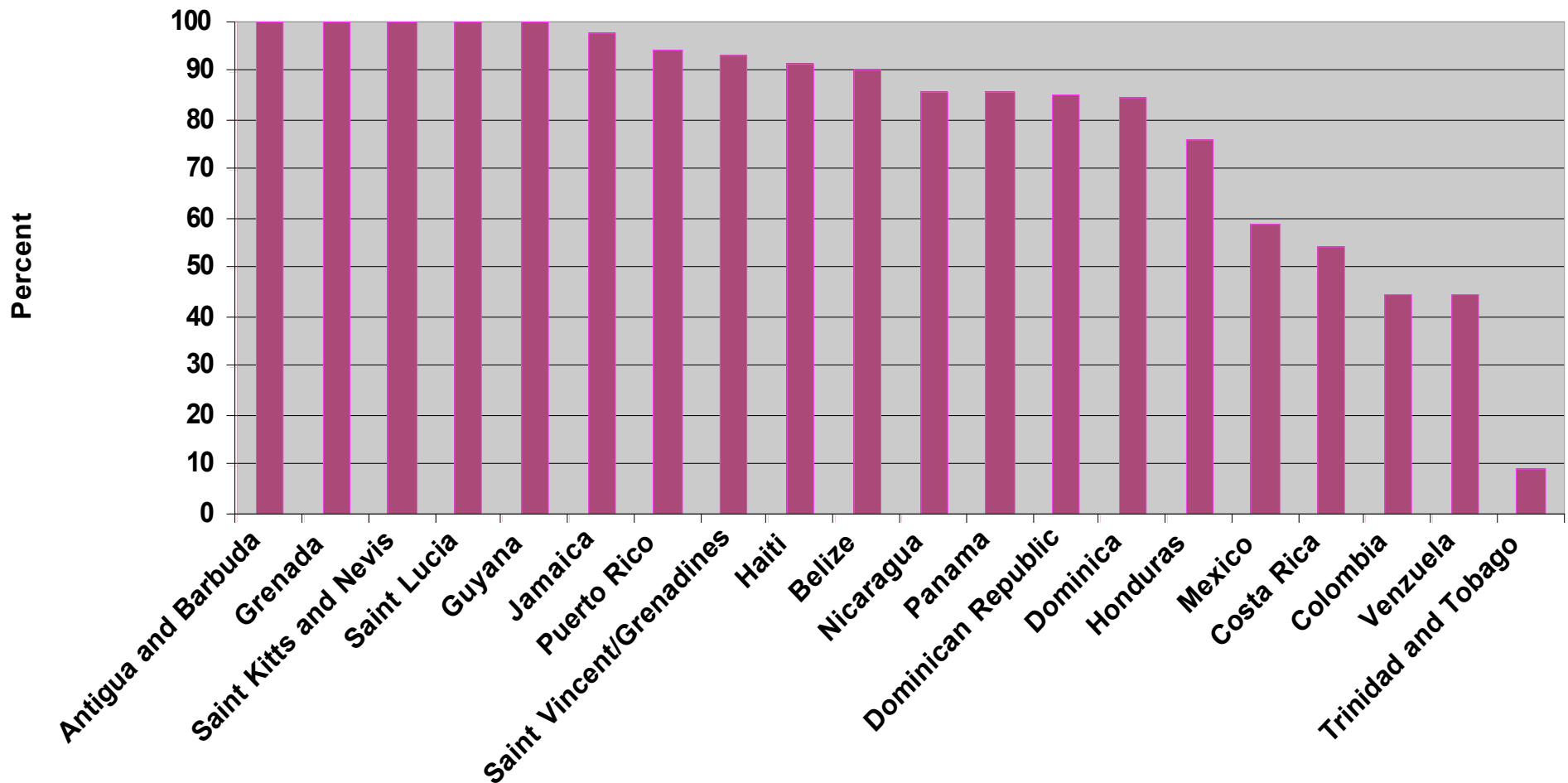
GDP/Capita for Caribbean Countries from 1980 to 2006

- GDP/Capita in 2000 USD

	Increasing	(+/-) Level	Decreasing
Island Countries	8	2	1
Mainland Countries	4	3	2

Dependence on Petroleum

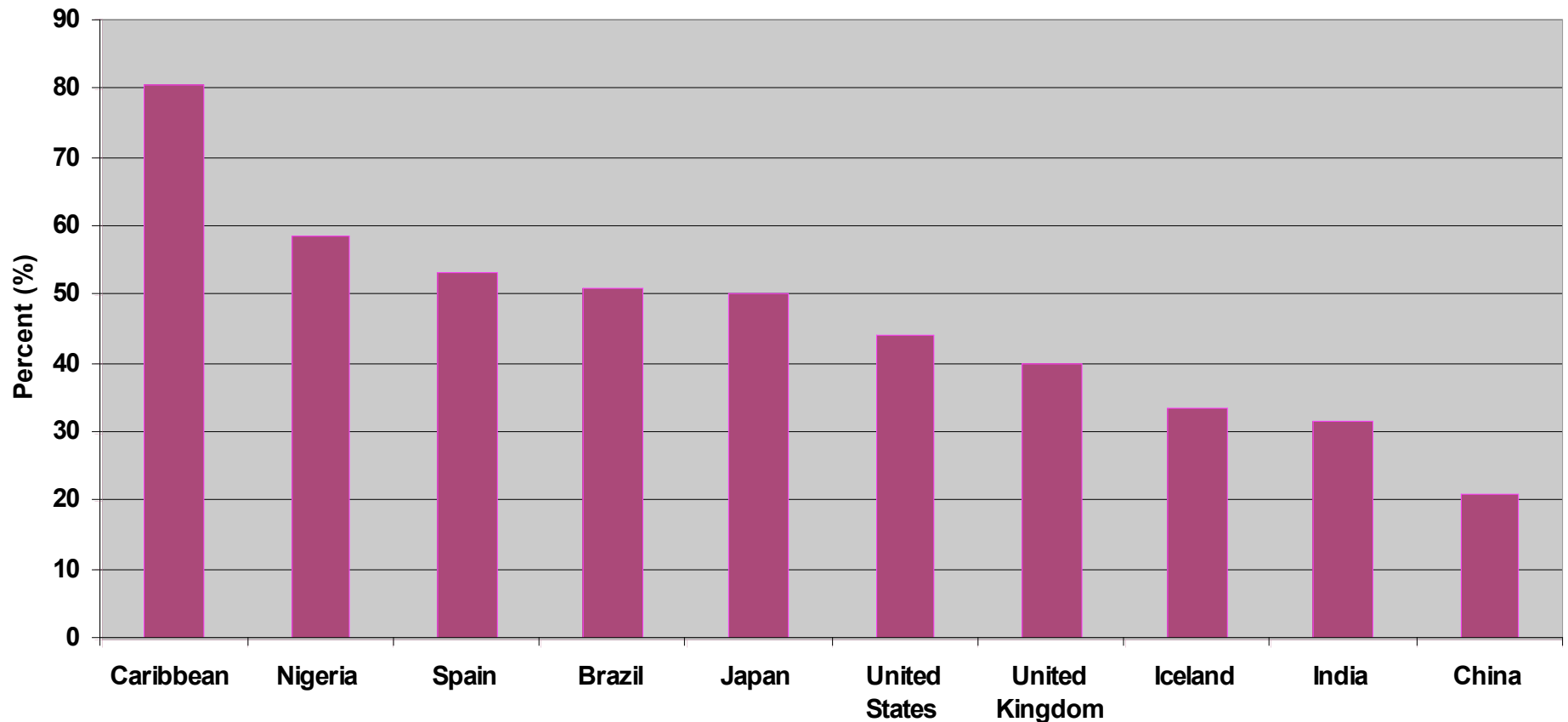
Petroleum as Percent of Total 2006 Energy Consumption



Note that data for Puerto Rico does not exceed the year 2001

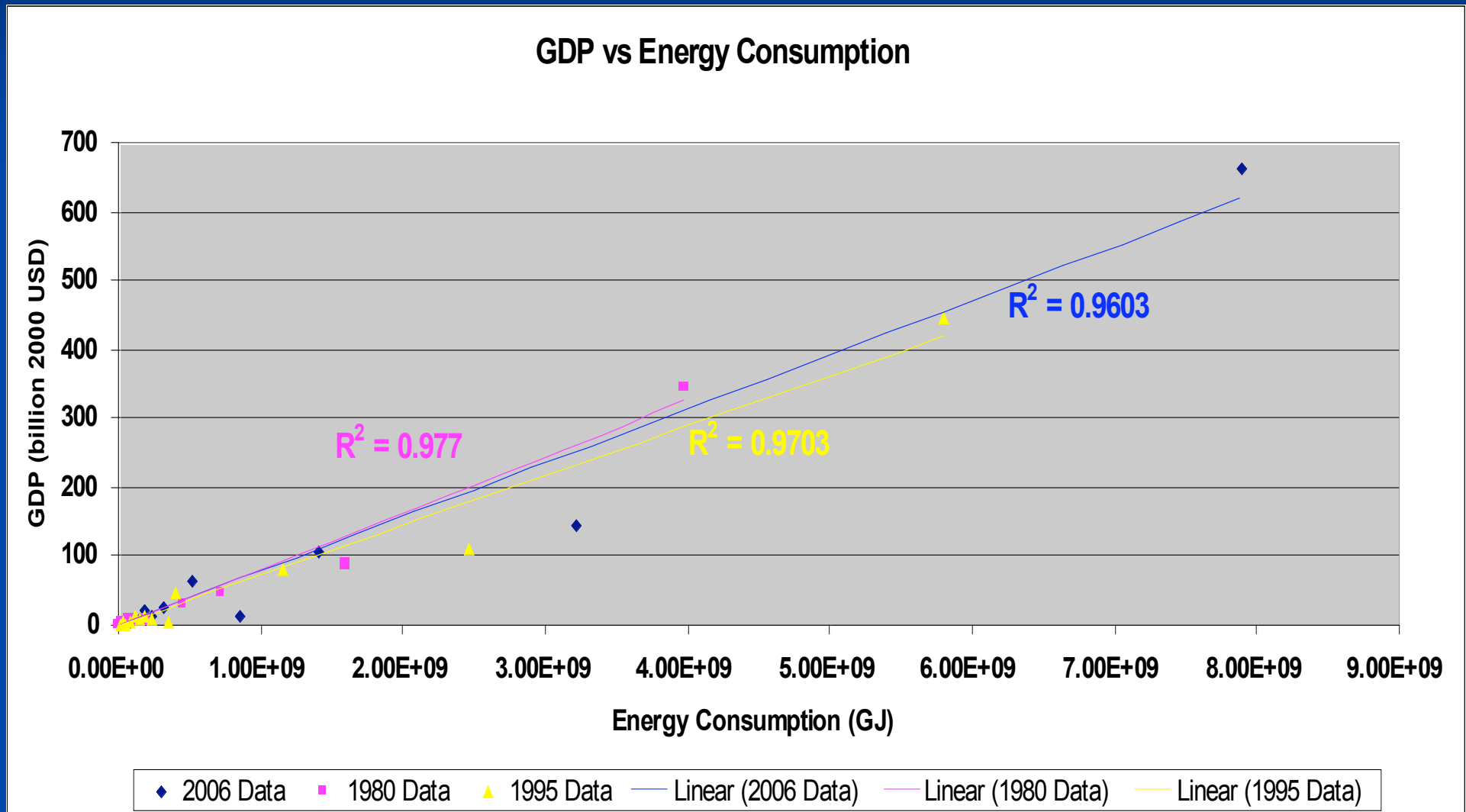
Dependence on Petroleum

Petroleum as % Total Energy Consumption 2005



Average of all 20 Caribbean countries taken here, although 4 have petroleum as 100% of total energy consumption

Linear Correlation between GDP and Energy Consumption



Efficiencies of Caribbean Countries from 1980 to 2006

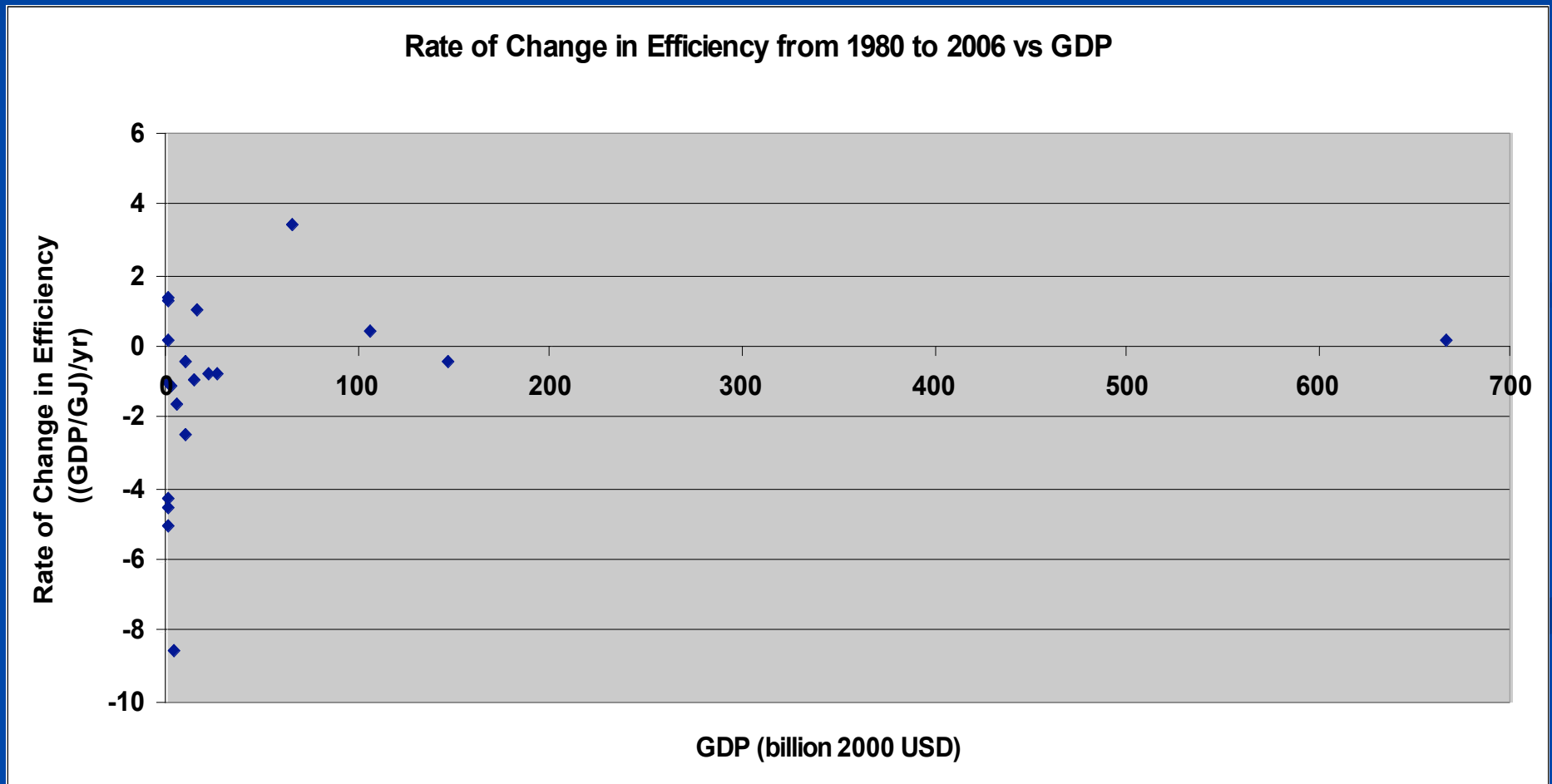
- GDP/Energy Consumption (GJ)

	Increasing	Decreasing
Island Countries	3	8
Mainland Countries	4	5
Total	7	13

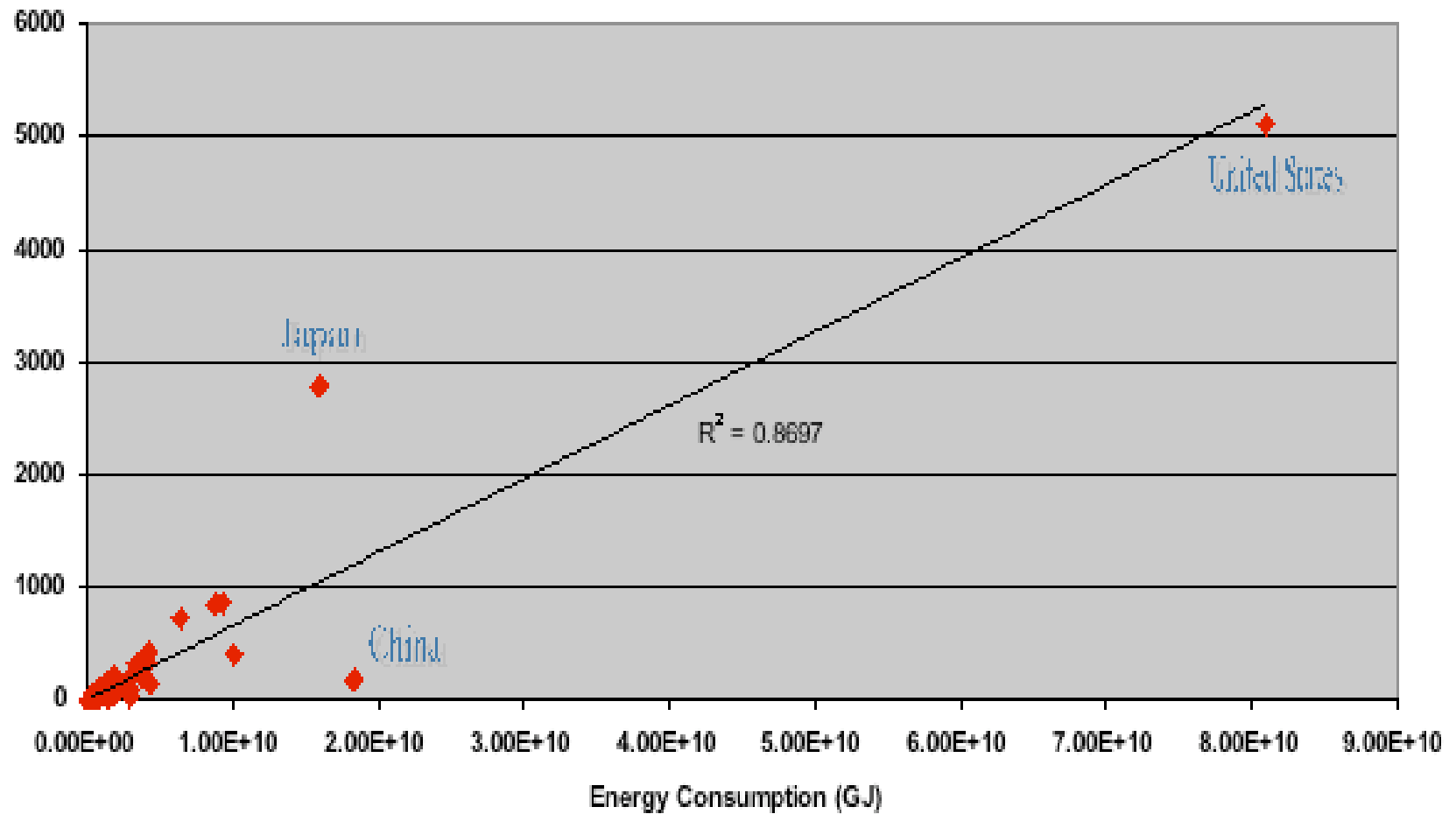
This does not support the hypothesis that efficiency is increasing.

Linear Correlation between Change in Efficiency and GDP?

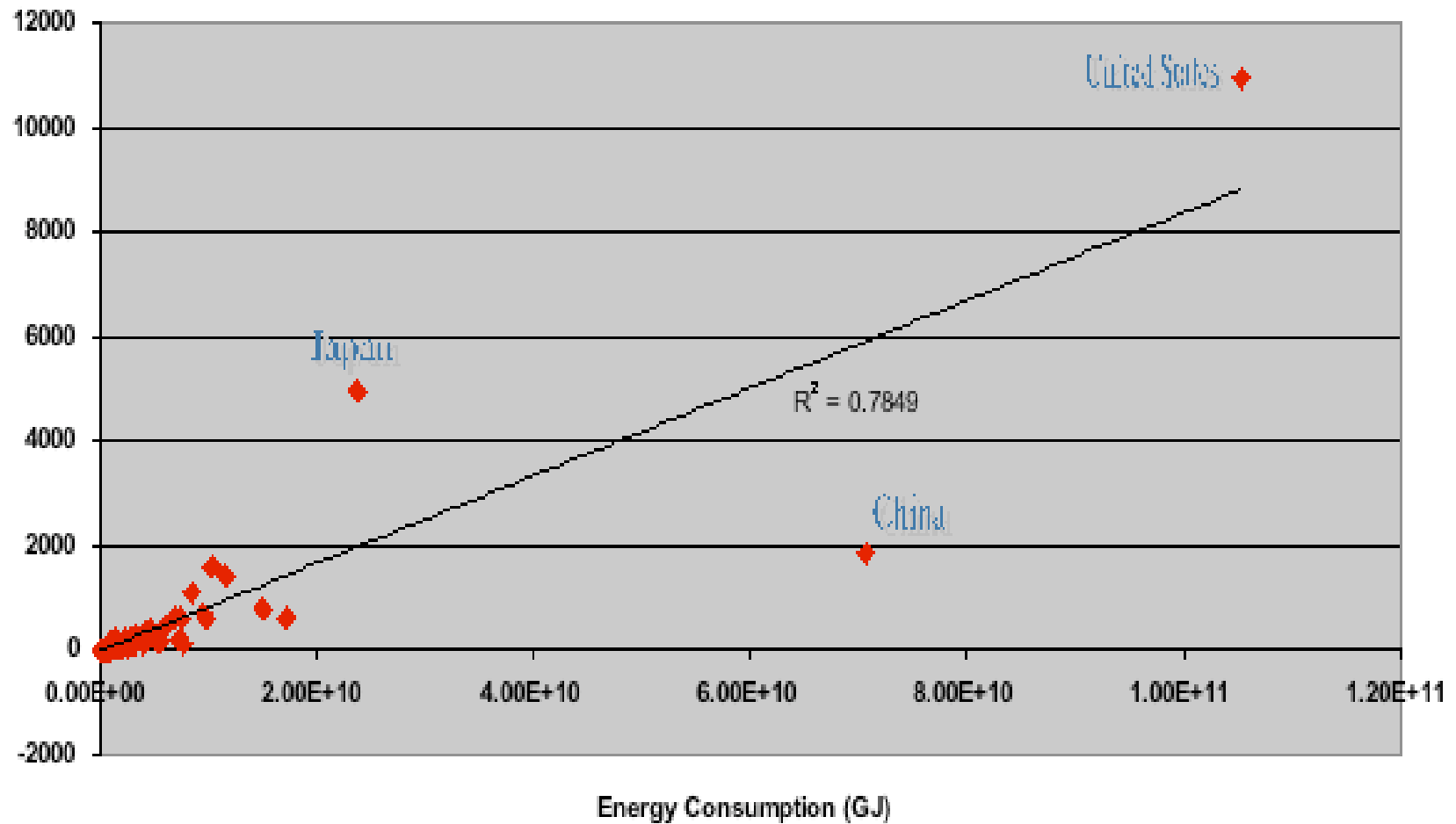
- Not quite: $R^2 = 0.0406$



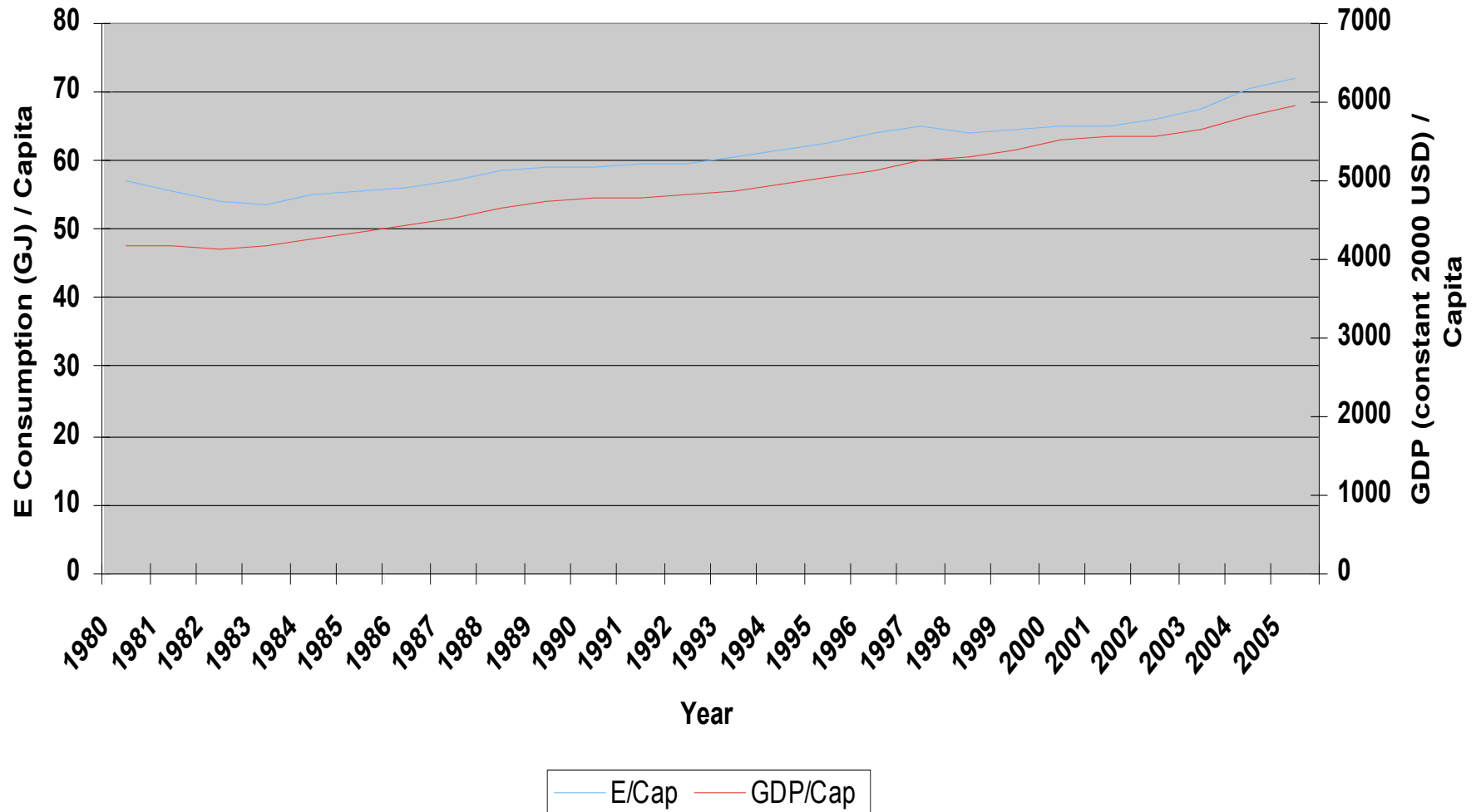
1980 GDP vs Energy Consumption for 127 of the World's Countries



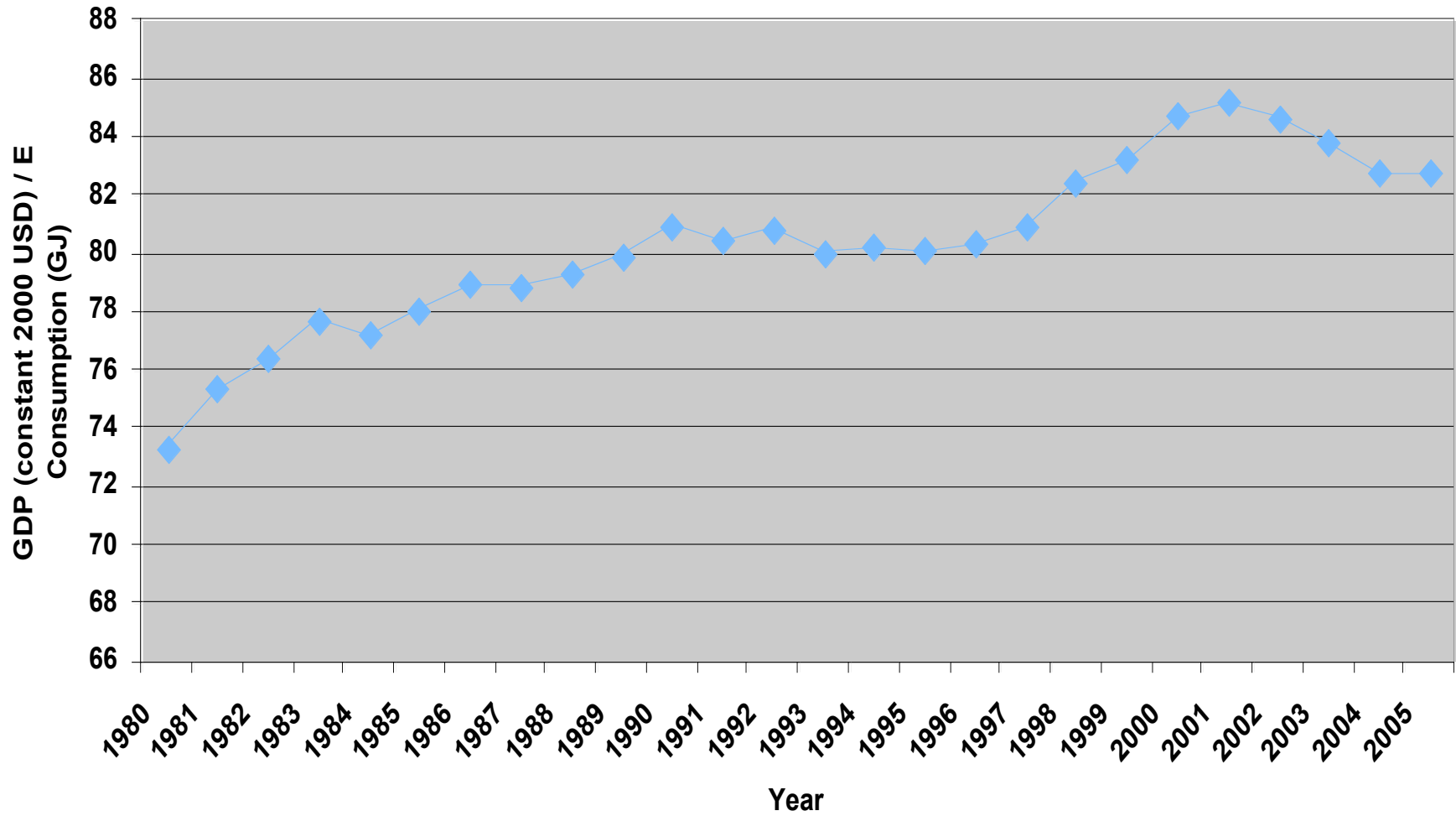
2005 GDP vs Energy Consumption for 127 of the World's Countries



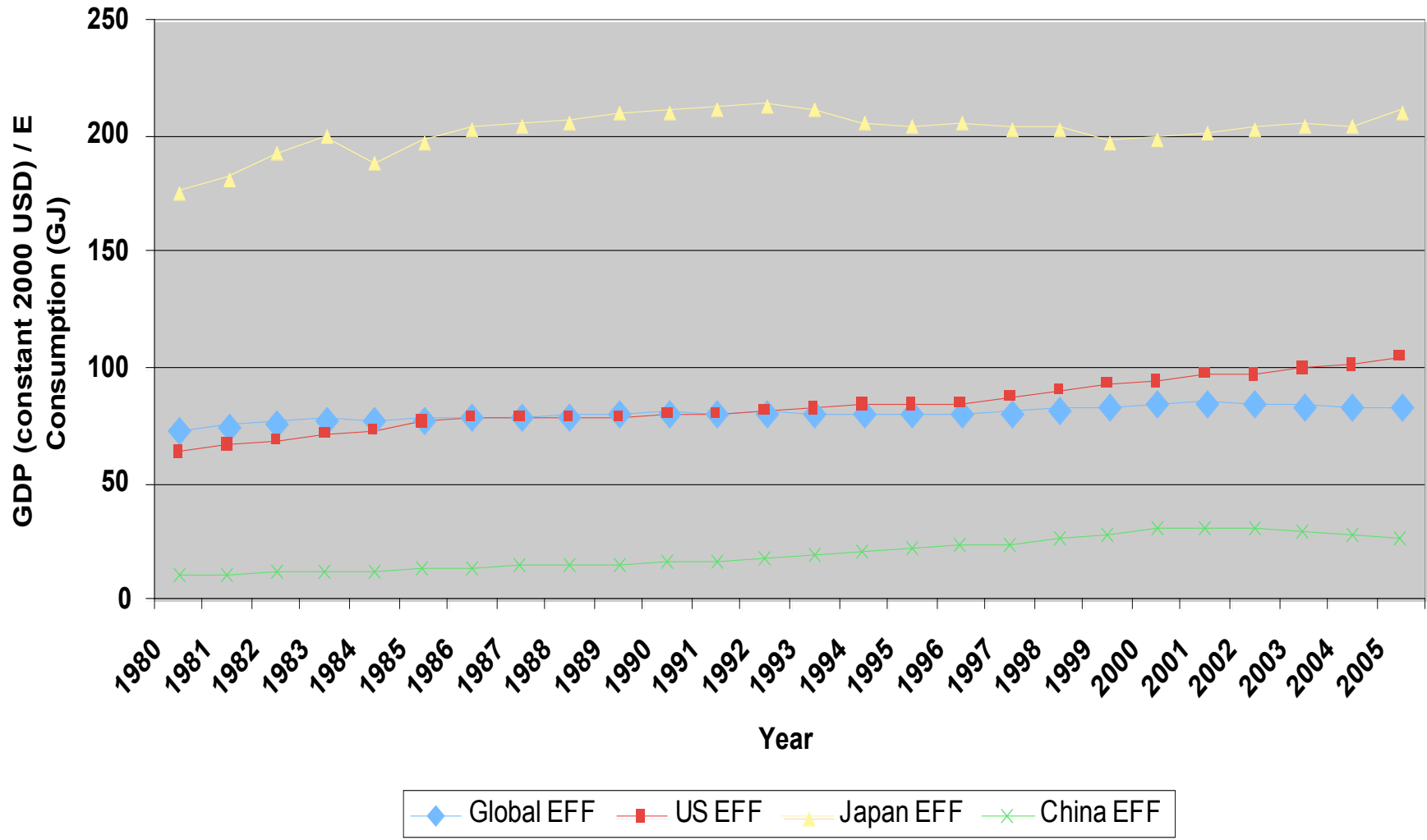
Global Energy Consumption and GDP per Capita



Global Efficiency Trend from 1980 to 2005



Global Efficiency Trend from 1980 to 2005

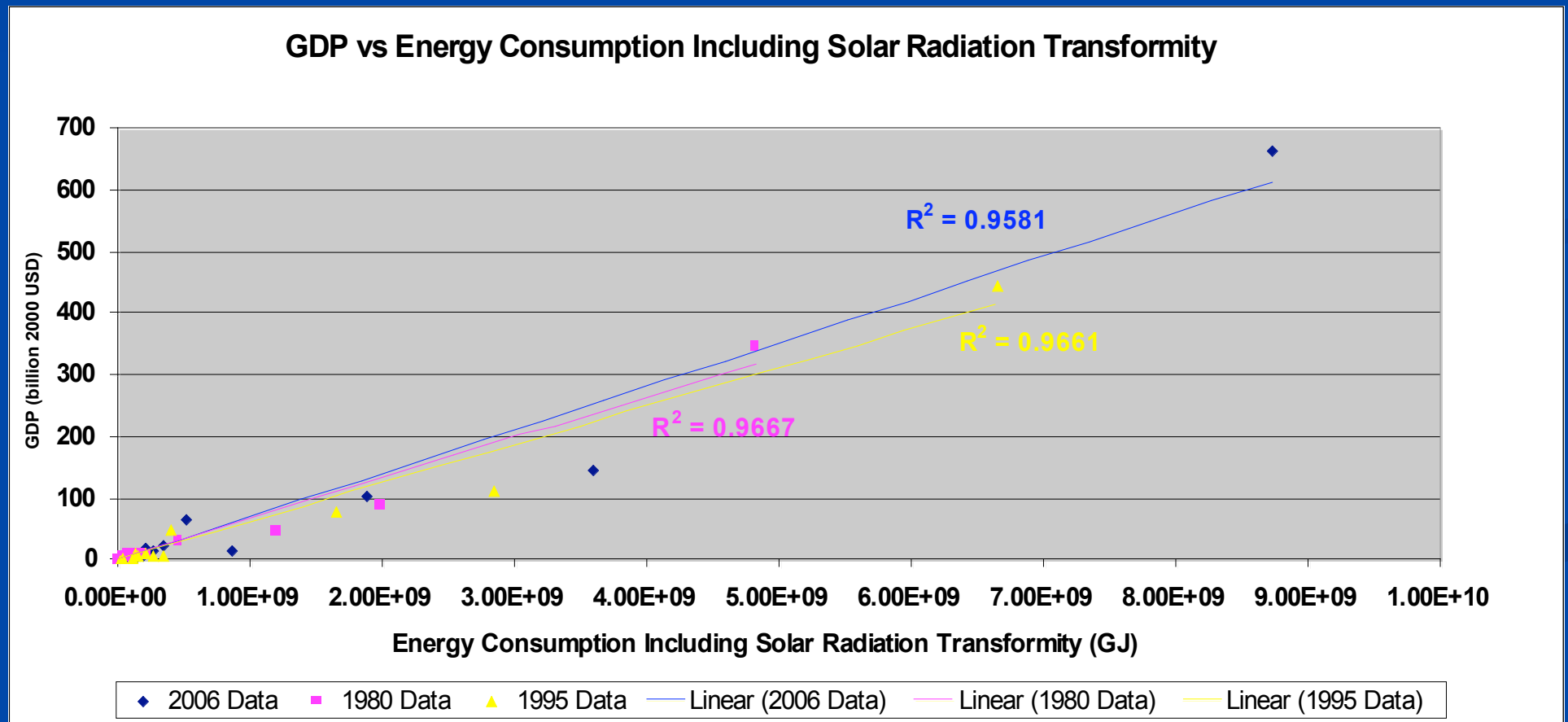


Emergy

- The transformity is defined as the emergy (in emjoules) of one kind of available energy required directly and indirectly (through all the pathways required) to make one joule of energy of another type.
- **Solar Transformity** = Solar emergy per unit available energy

Effect of Emergy on Correlation between GDP and Energy Consumption

- Solar radiation transformity into fossil fuels was added to the energy consumption for 2006:
- Slight decrease in correlation:



Global Efficiency Trend from 1980 to 2005

