



Energy and Economic Growth: The “Stylized Facts”

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Kaldor's Stylized Facts:

“In 1961, Nicholas Kaldor highlighted six “stylized” facts to summarize the patterns that economists had discovered in national income accounts and to shape the growth models being developed to explain them.”

(Jones and Romer, 2010, *AEJ: Macroeconomics* 2(1): 224)

Kaldor's Stylized Facts:

In the long-run:

1. GDP and labor productivity grow at a constant rate
2. Increasing capital per worker
3. Constant rate of return on capital
4. Constant capital/GDP ratio
5. Constant shares of wages and profits in GDP
6. Growth rates vary across countries

Jones and Romer's Stylized Facts:

In the long-run:

1. Increase in the extent of the market
2. Accelerating growth rate
3. Variation in growth rates higher in lower income countries
4. Large variation in income and TFP across countries
5. Increasing human capital per worker
6. Stable return to human capital relative to unskilled wages

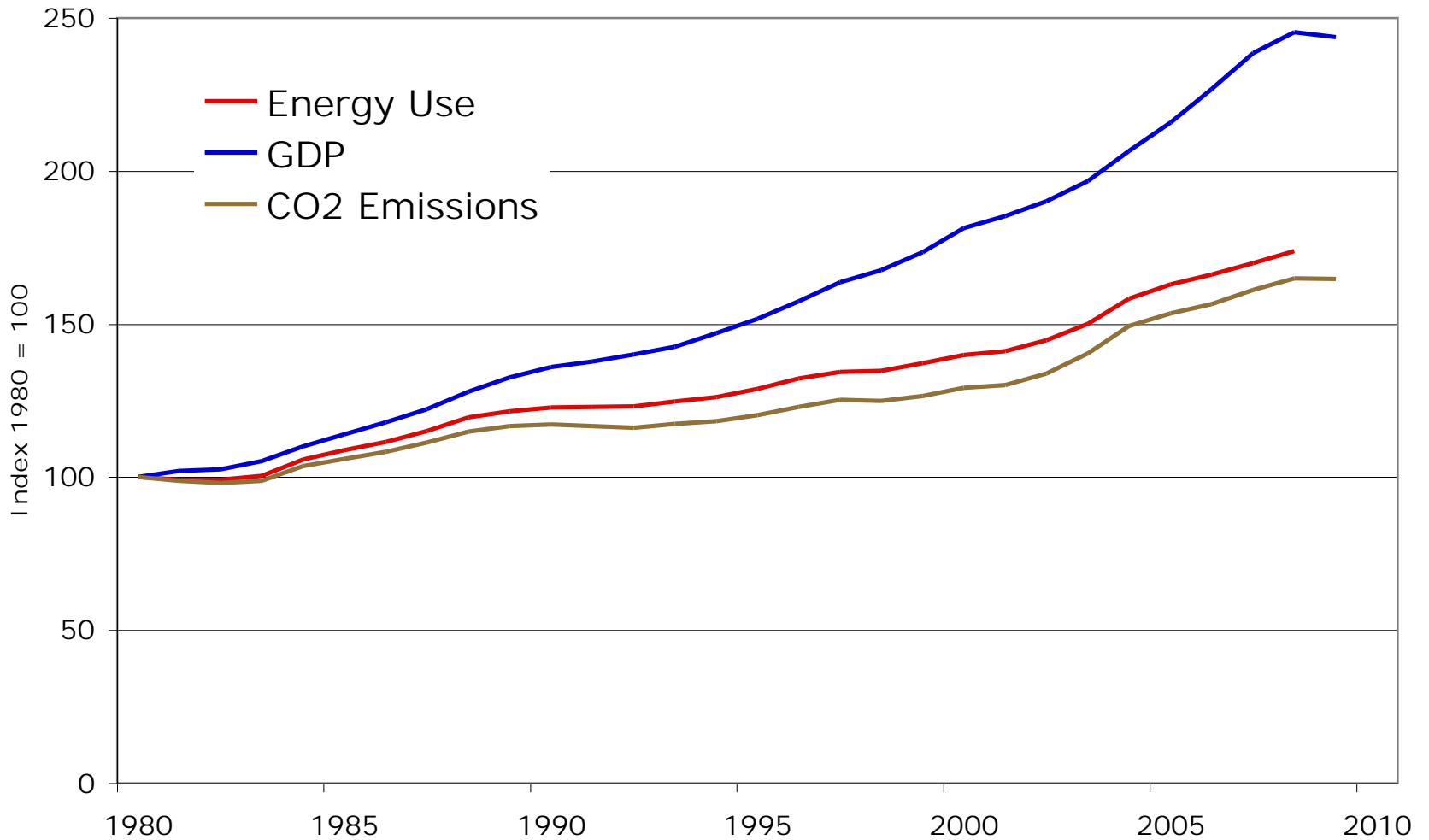
1

Energy use per
capita increases
over time

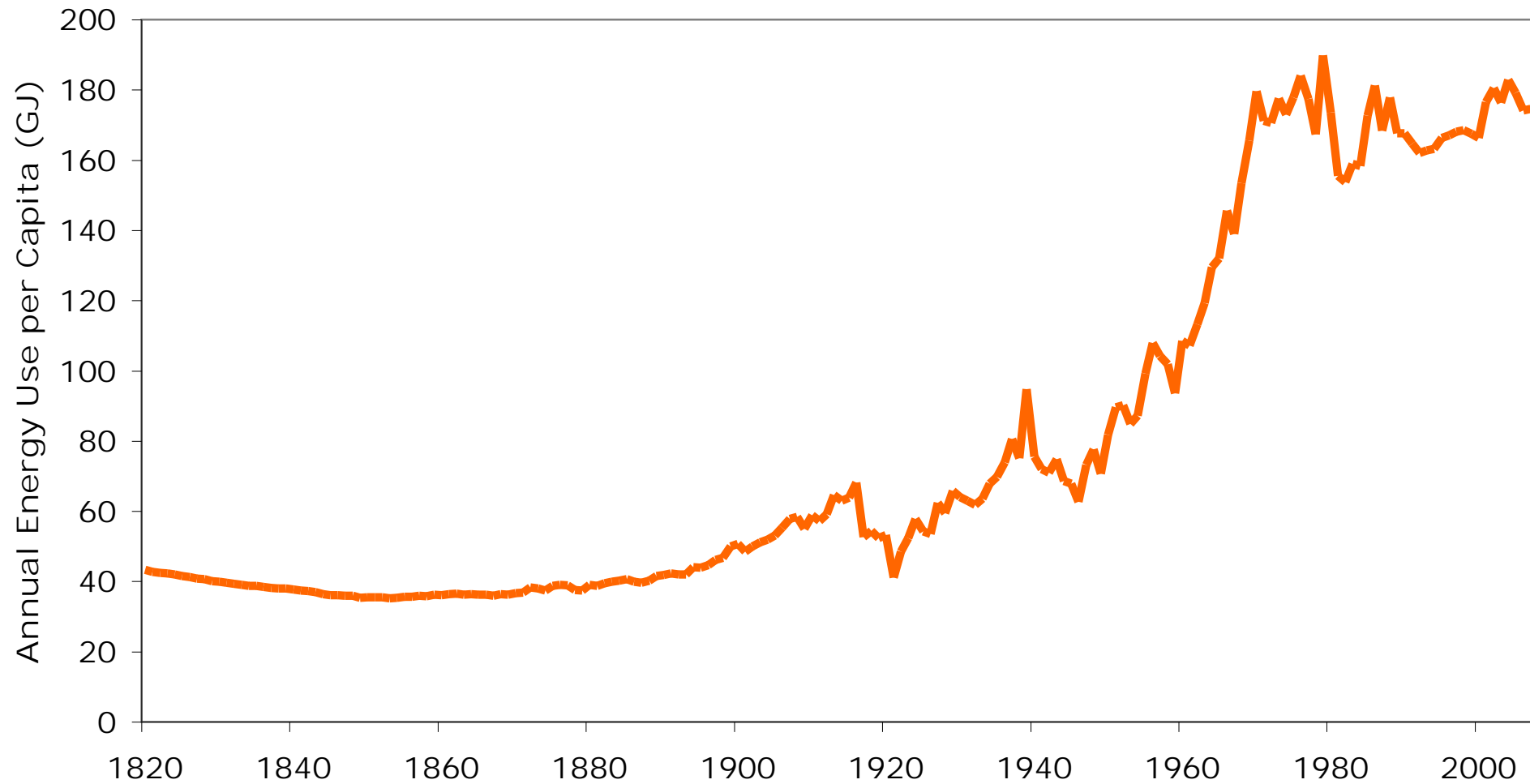
Energy & Growth:

The Stylized Facts

World Energy, GDP, and CO2: 1980-2009



Swedish Energy Use Per Capita 1820-2007



Energy and Growth Meta-Analysis

- Does increasing energy use cause growth? Or vice-versa?
- Large literature testing energy-growth Granger causality

Energy and Growth Meta-Analysis

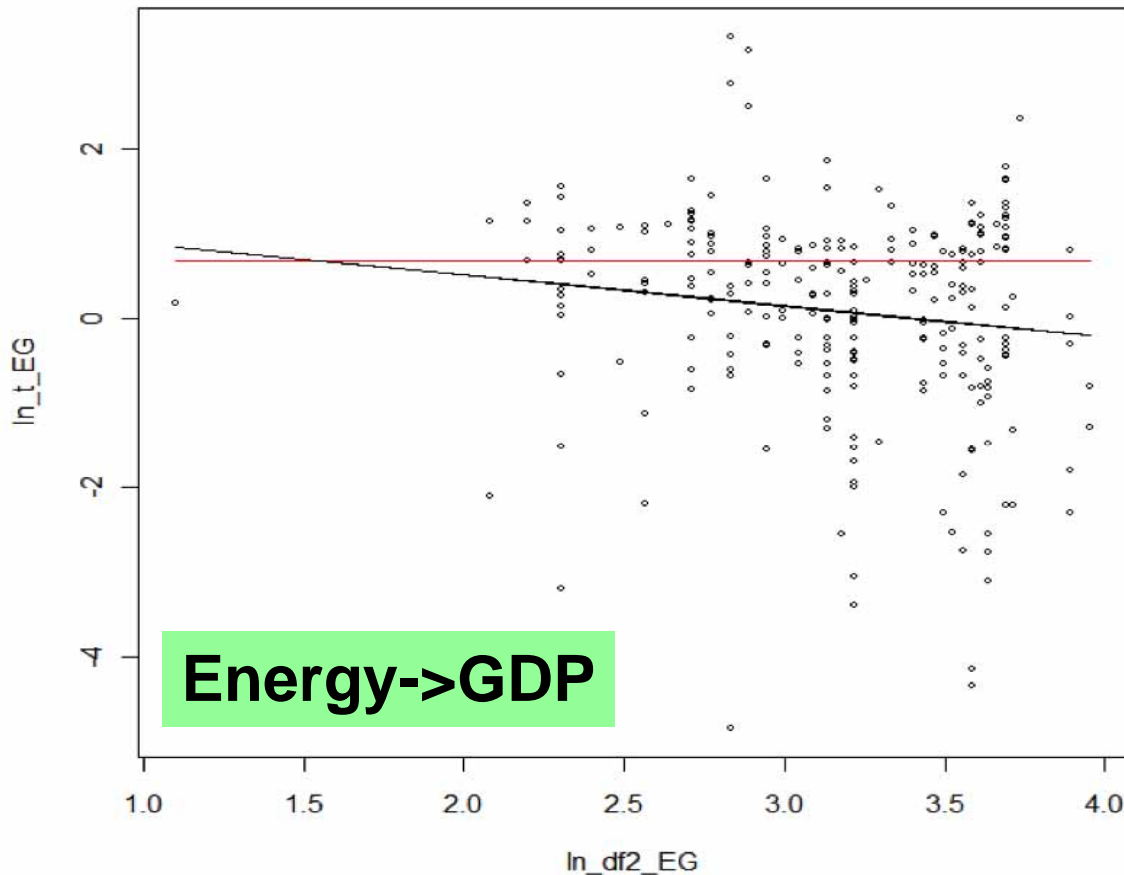
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Multivariate Production Function Models

Model	Period	Energy -> GDP	GDP -> Energy
Multivariate GDP, DE, K, L	1850-2000	2.3686 (0.056)	1.6173 (0.174)
	1900-2000	1.8515 (0.128)	0.588 (0.672)
	1950-2000	1.2092 (0.331)	3.4115 (0.023)
Multivariate GRO, DE, K, L	1850-2000	4.5479 (0.002)	0.3397 (0.851)
	1900-2000	1.5271 (0.203)	1.4746 (0.218)
	1950-2000	2.9842 (0.037)	2.7127 (0.052)

Energy and Growth Meta-Analysis

- Does increasing energy use cause growth? Or vice-versa?
- Large literature testing energy-growth Granger causality
- Meta-significance testing: $\ln|t_i| = \alpha + \beta \ln DF_i + \varepsilon_i$



Christian Gross



Stephan Bruns

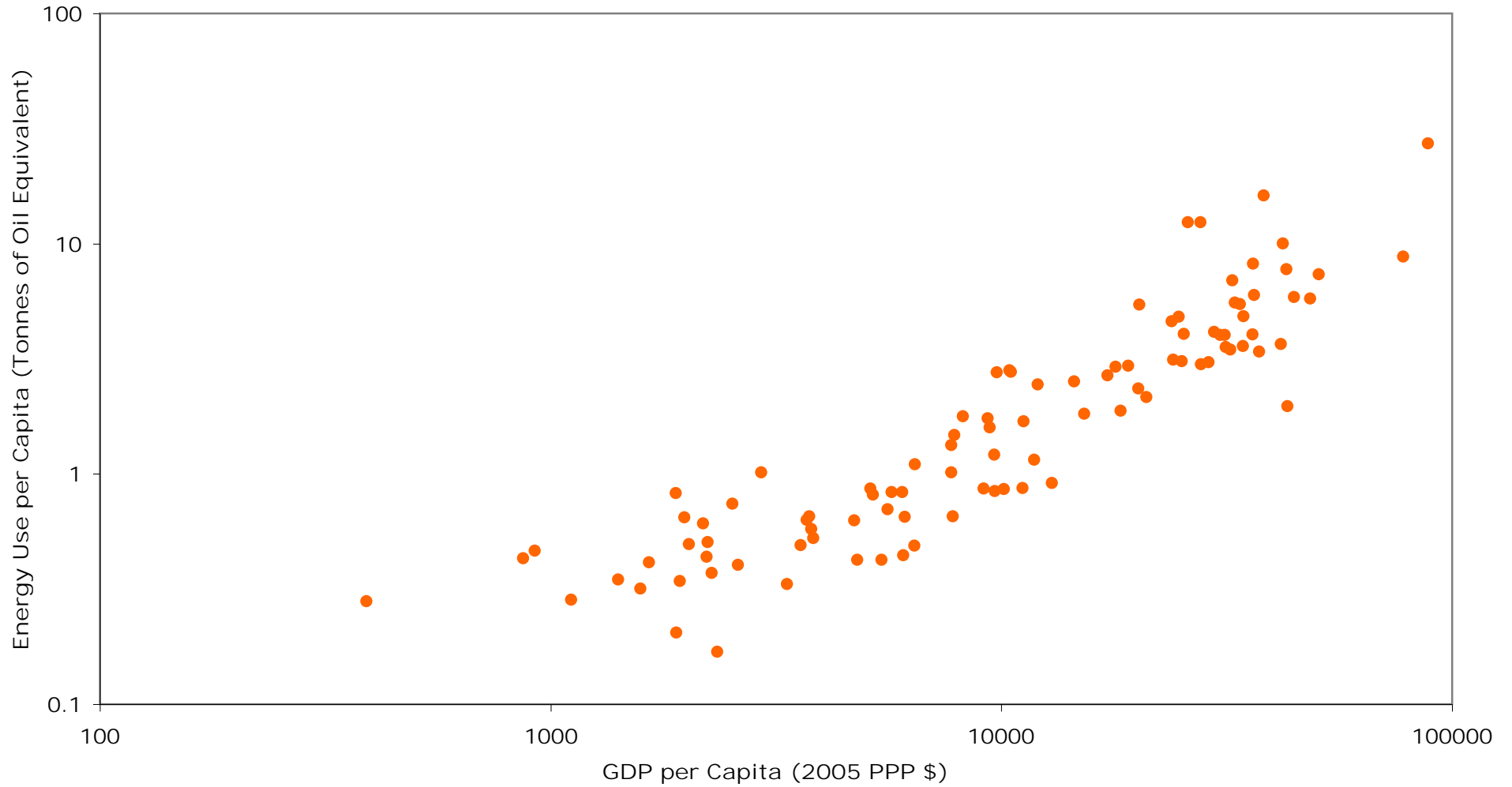
2

Energy use per capita increases with GDP per capita

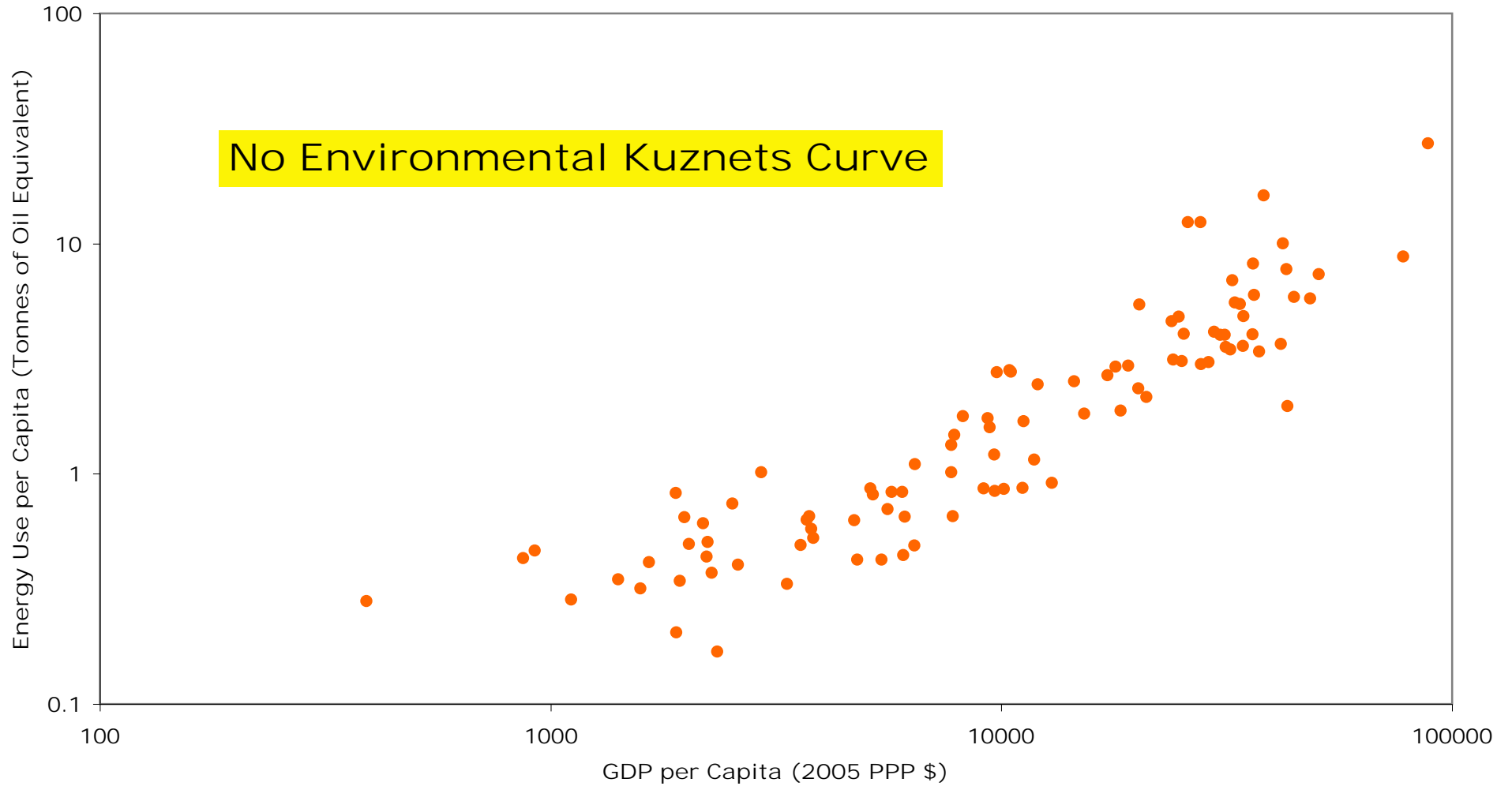
Energy & Growth:

The Stylized Facts

Energy and Income per Capita 2007



Energy and Income per Capita 2007



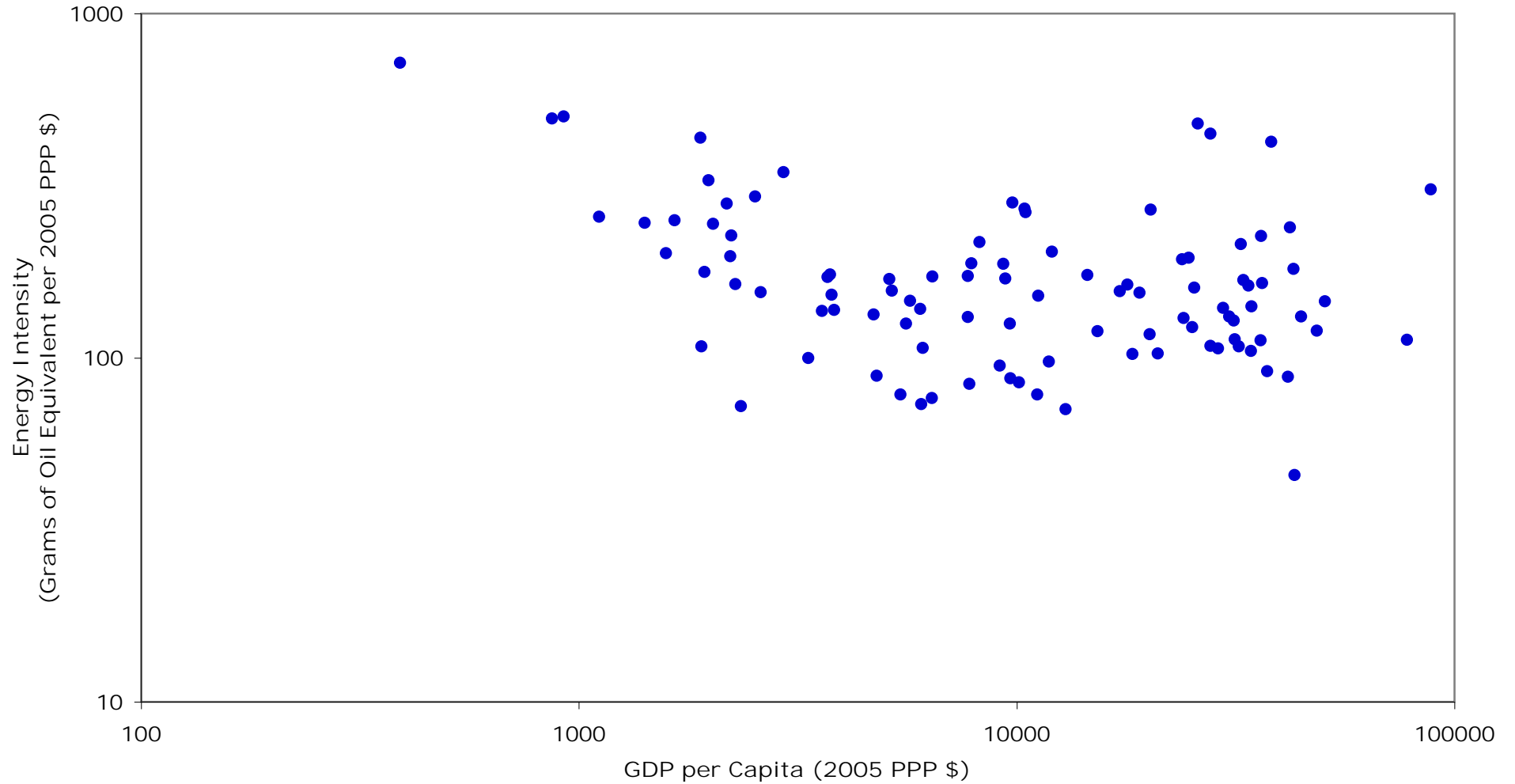
3

Energy intensity is
not correlated with
GDP per capita

Energy & Growth:

The Stylized Facts

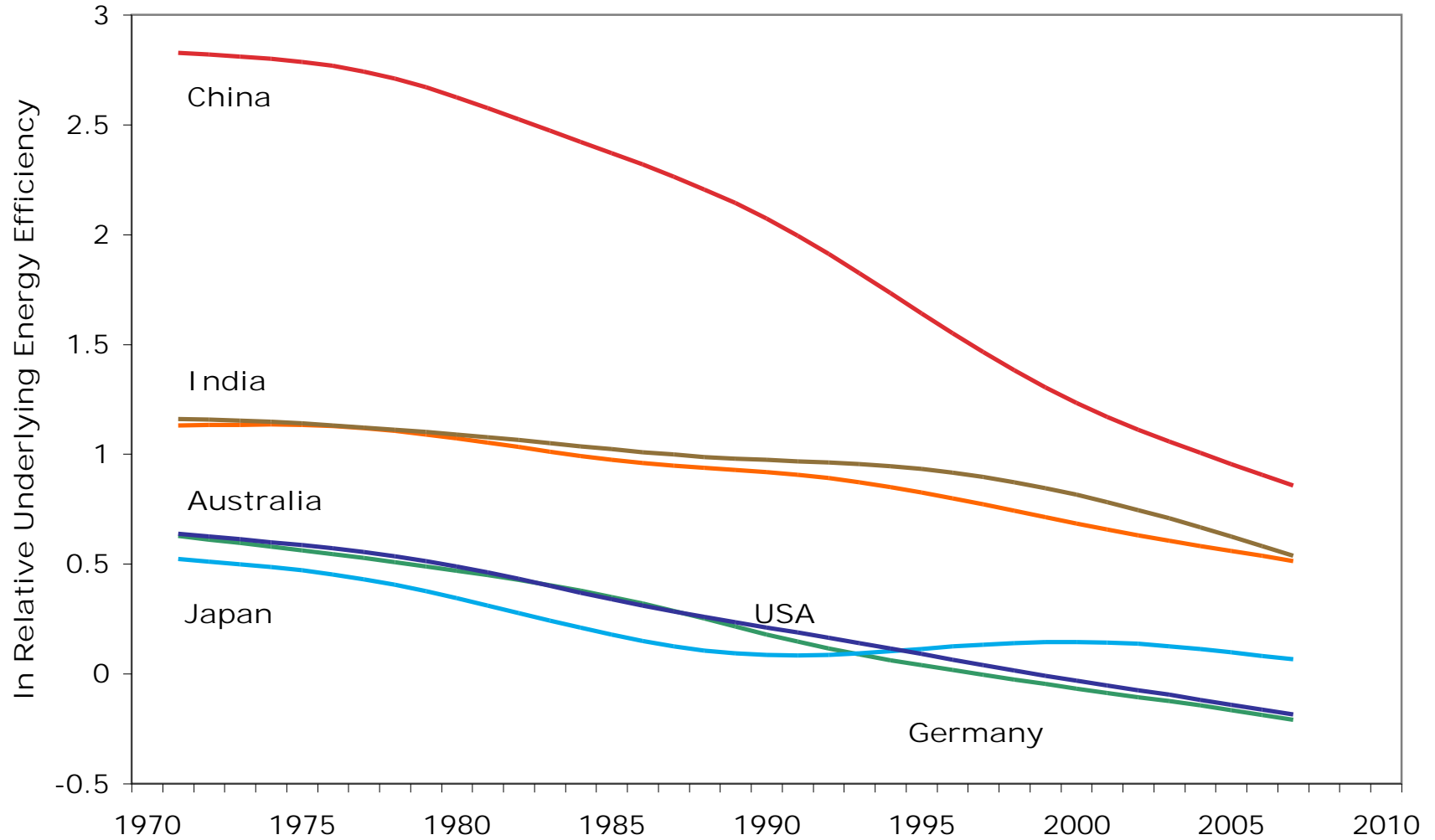
Energy Intensity & GDP per Capita 2007



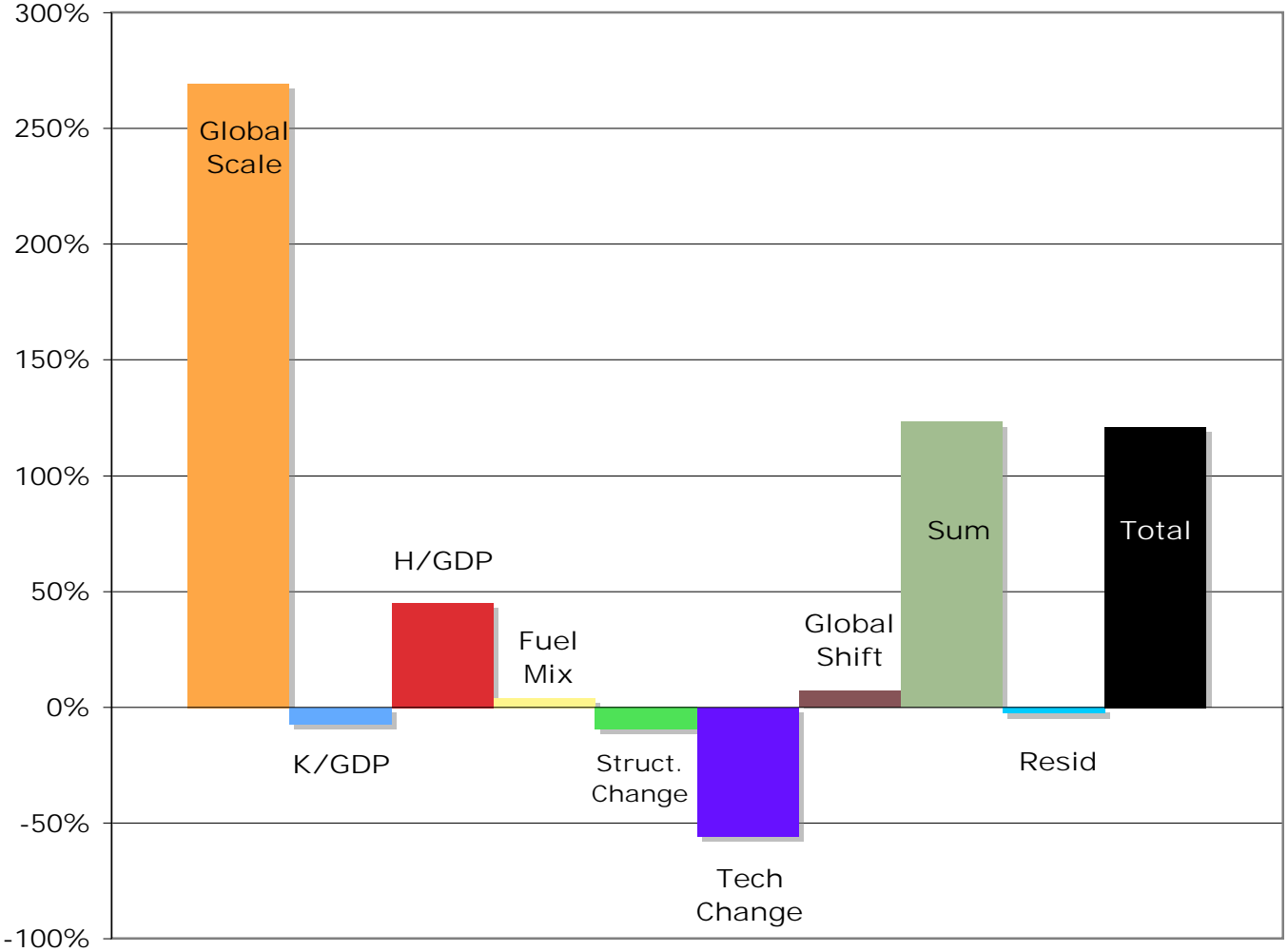
Key Variables (2007): Australia & Other Countries

	Winter Temp	Mining & Utilities	Coal	TFP	PPP	Fossil Reserves / GDP
Australia	15.2	10%	44%	0.88	1.15	55.87
Canada	-20.4	10%	11%	0.85	1.11	26.06
China	-5.8	14%	66%	0.39	0.32	7.40
Germany	0.2	2%	26%	0.84	1.21	1.06
India	17.1	5%	41%	0.36	0.25	10.27
Japan	0.8	3%	22%	0.77	1.07	0.07
UK	3.4	4%	18%	0.98	1.33	0.68
USA	-2.7	4%	24%	1	1	10.02

Underlying Energy Efficiency: Chindia & Developed Economies



Decomposition of Increase in Global Energy Use, 1971-2007



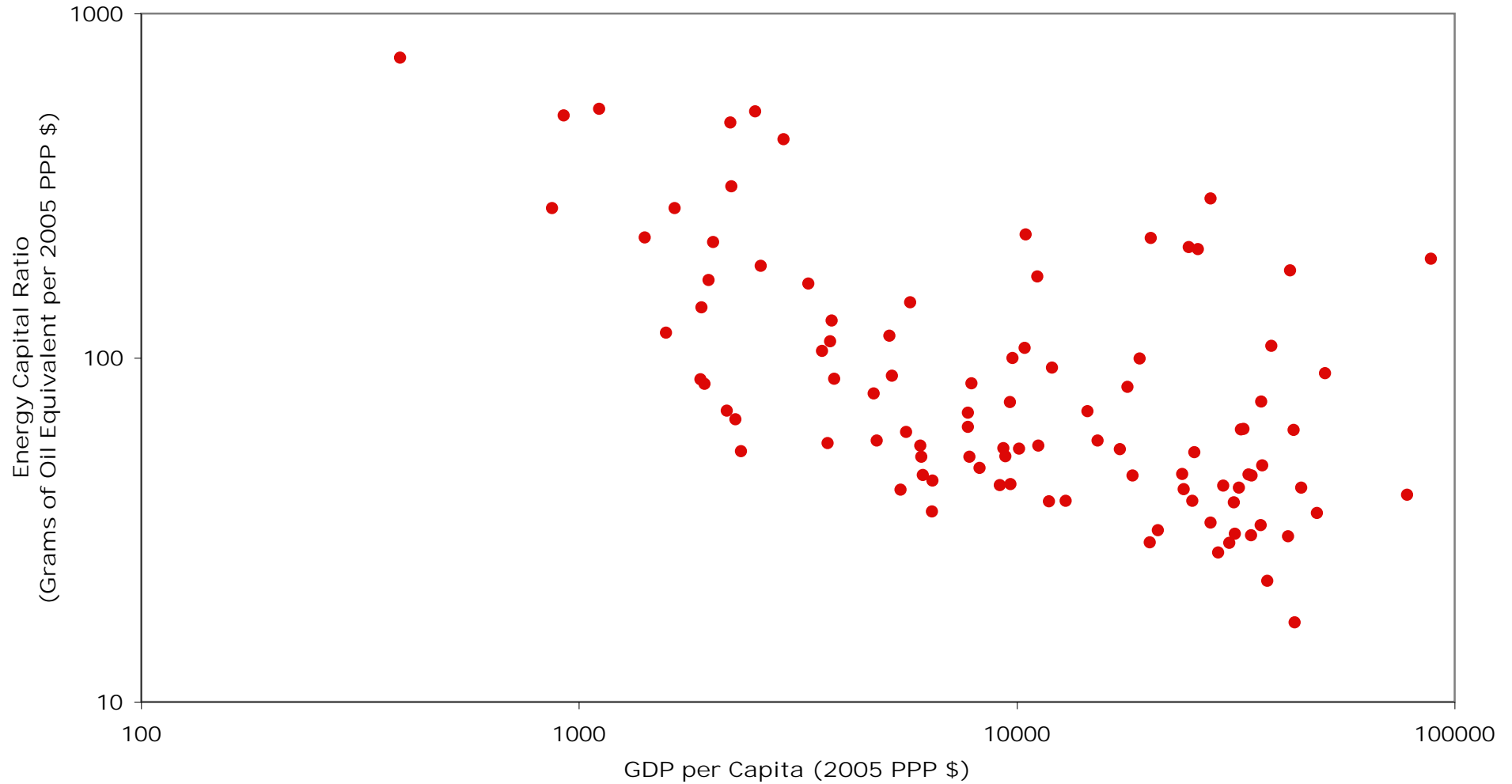
4

Energy/capital is
negatively
correlated with GDP
per capita

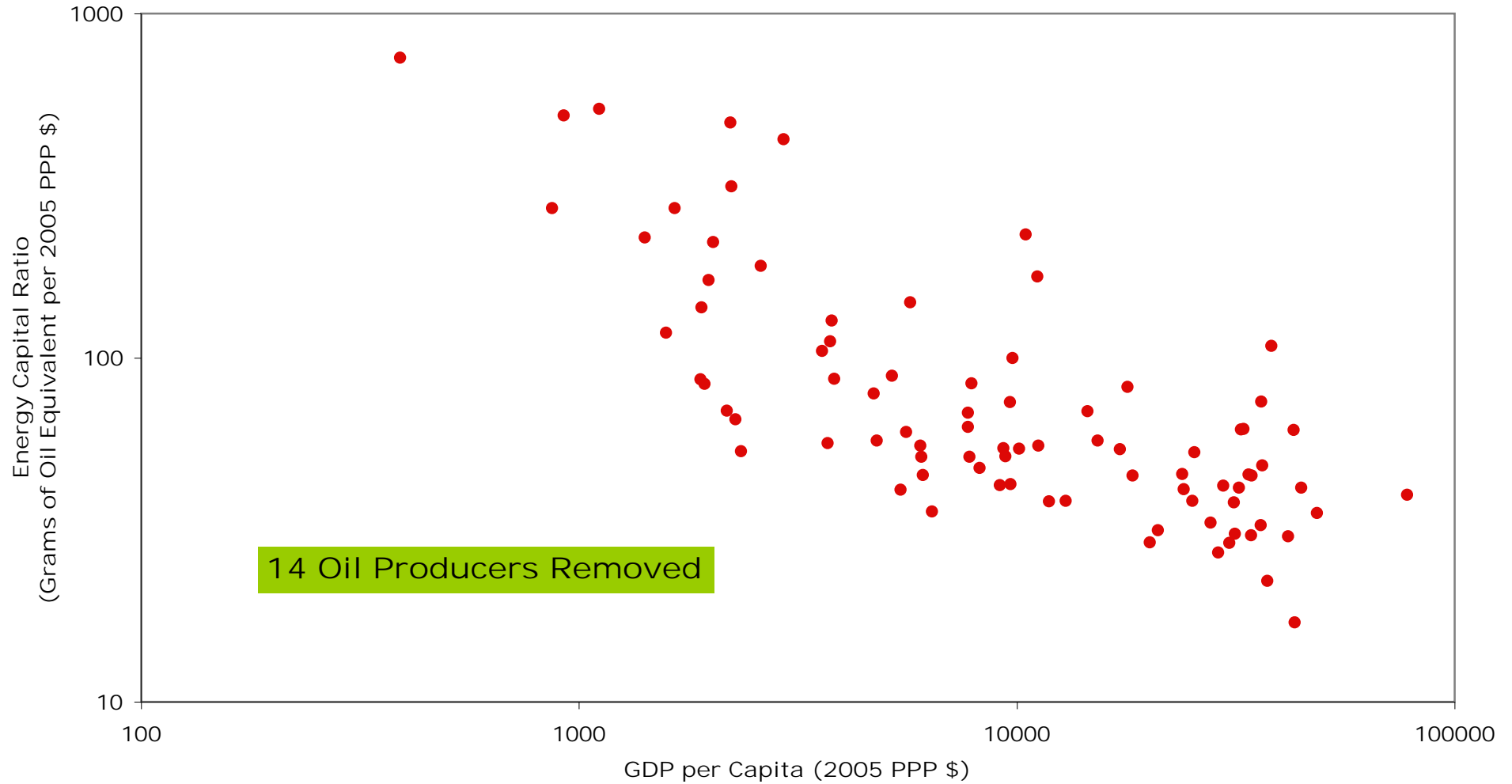
Energy & Growth:

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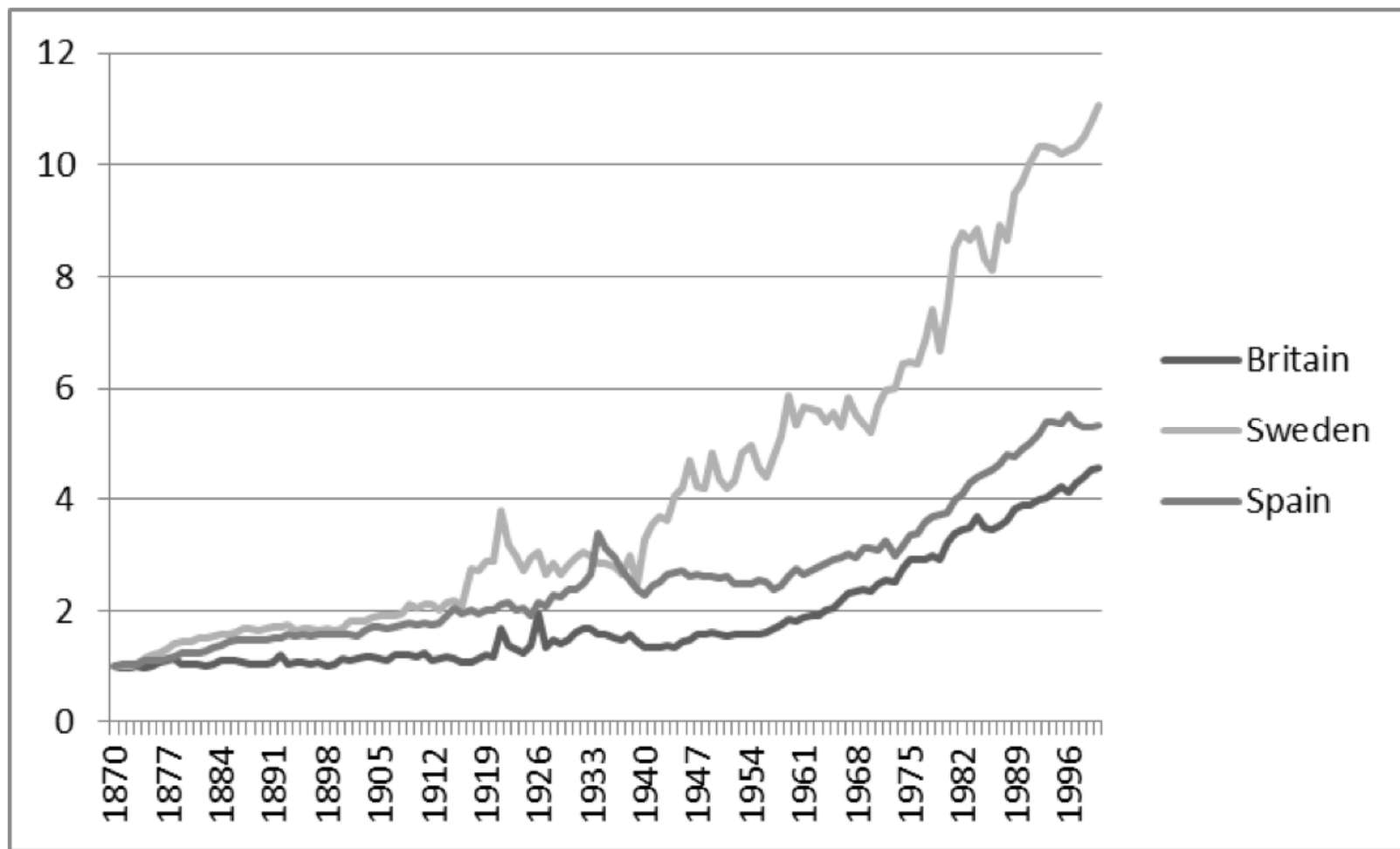
Energy Capital Ratio & GDP per Capita 2007



Energy Capital Ratio & GDP per Capita 2007



Capital/Energy Ratio in the Long Run



Source: Kander (in press)

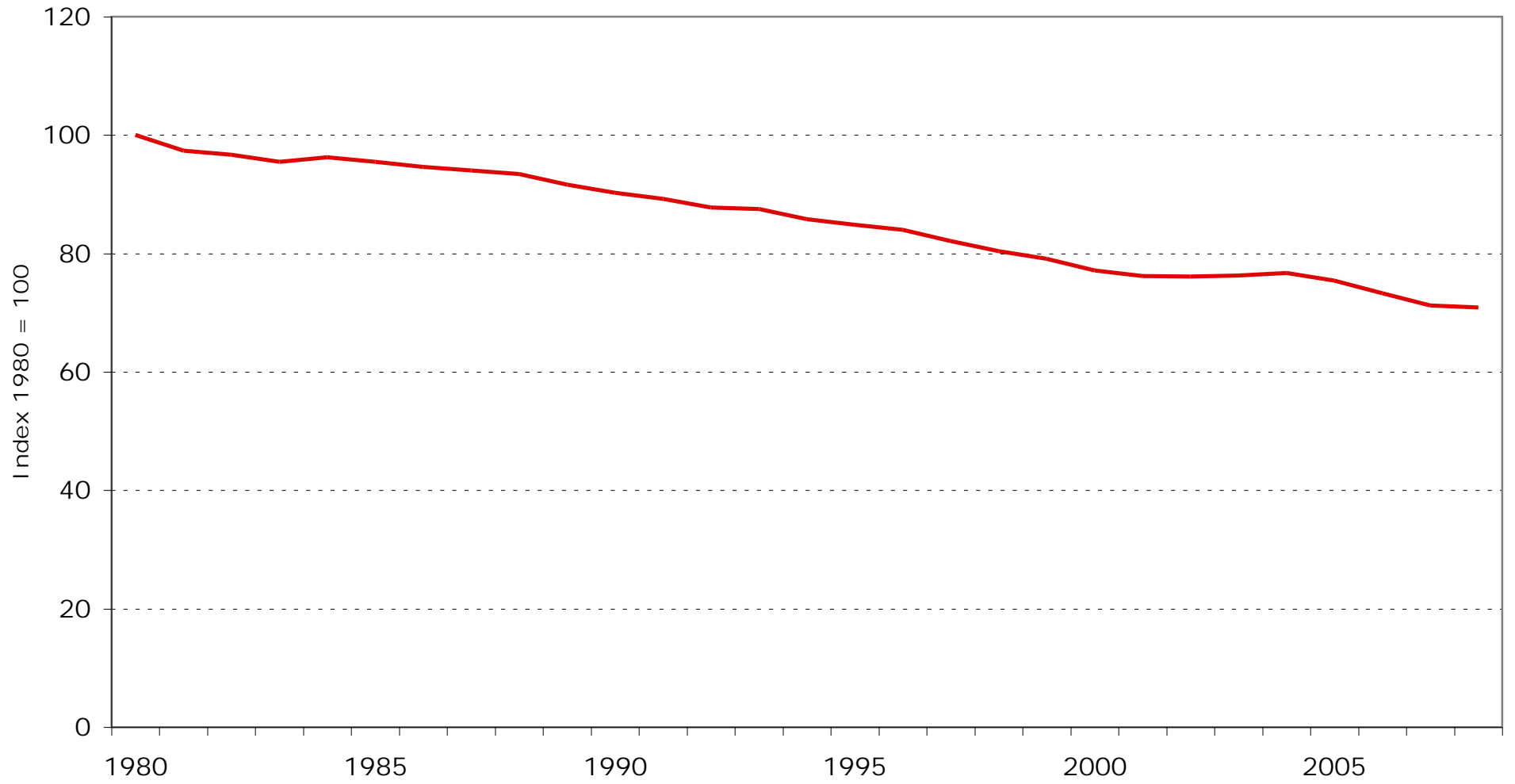
5

Energy intensity
declines over time

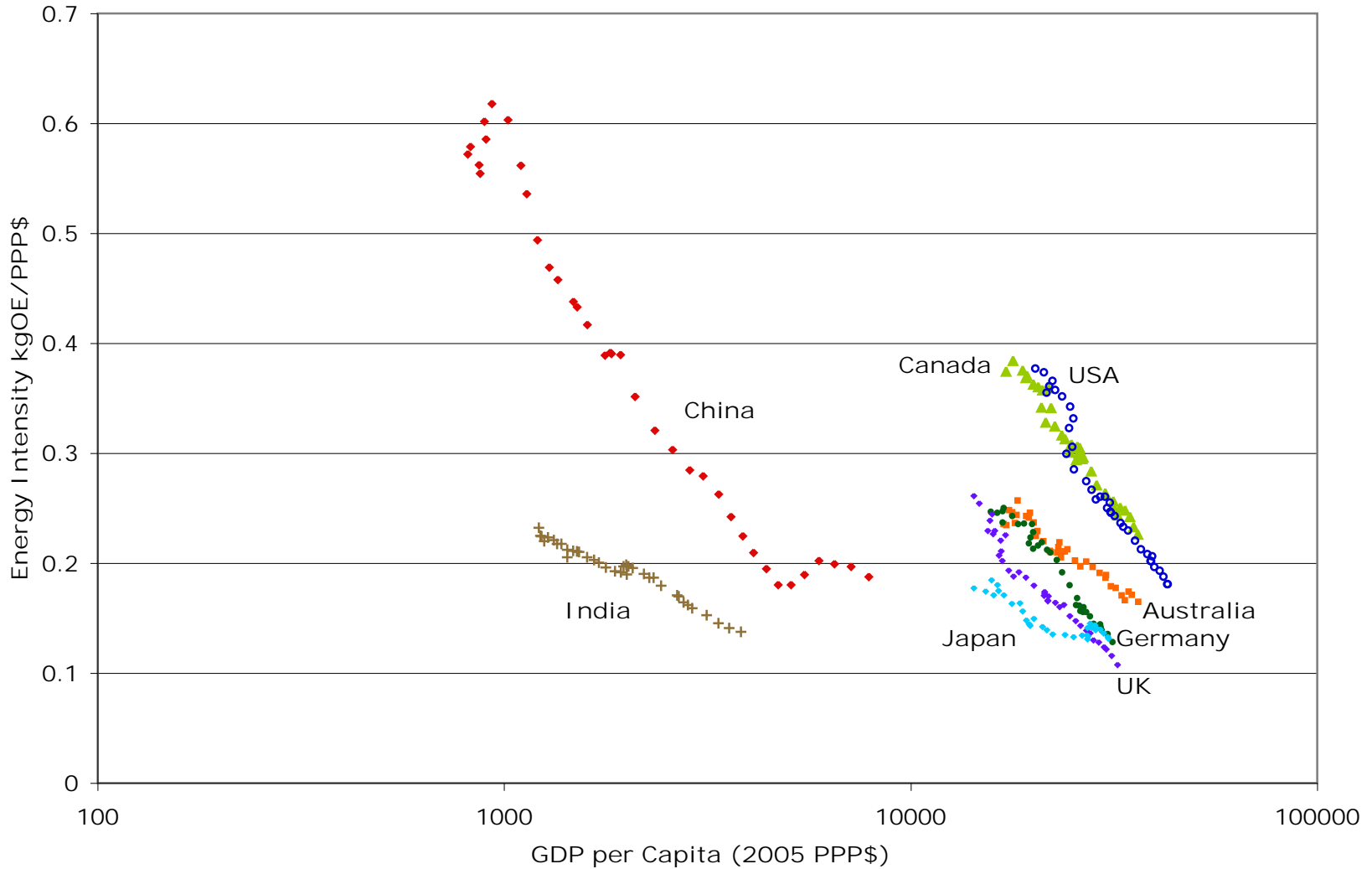
Energy & Growth:

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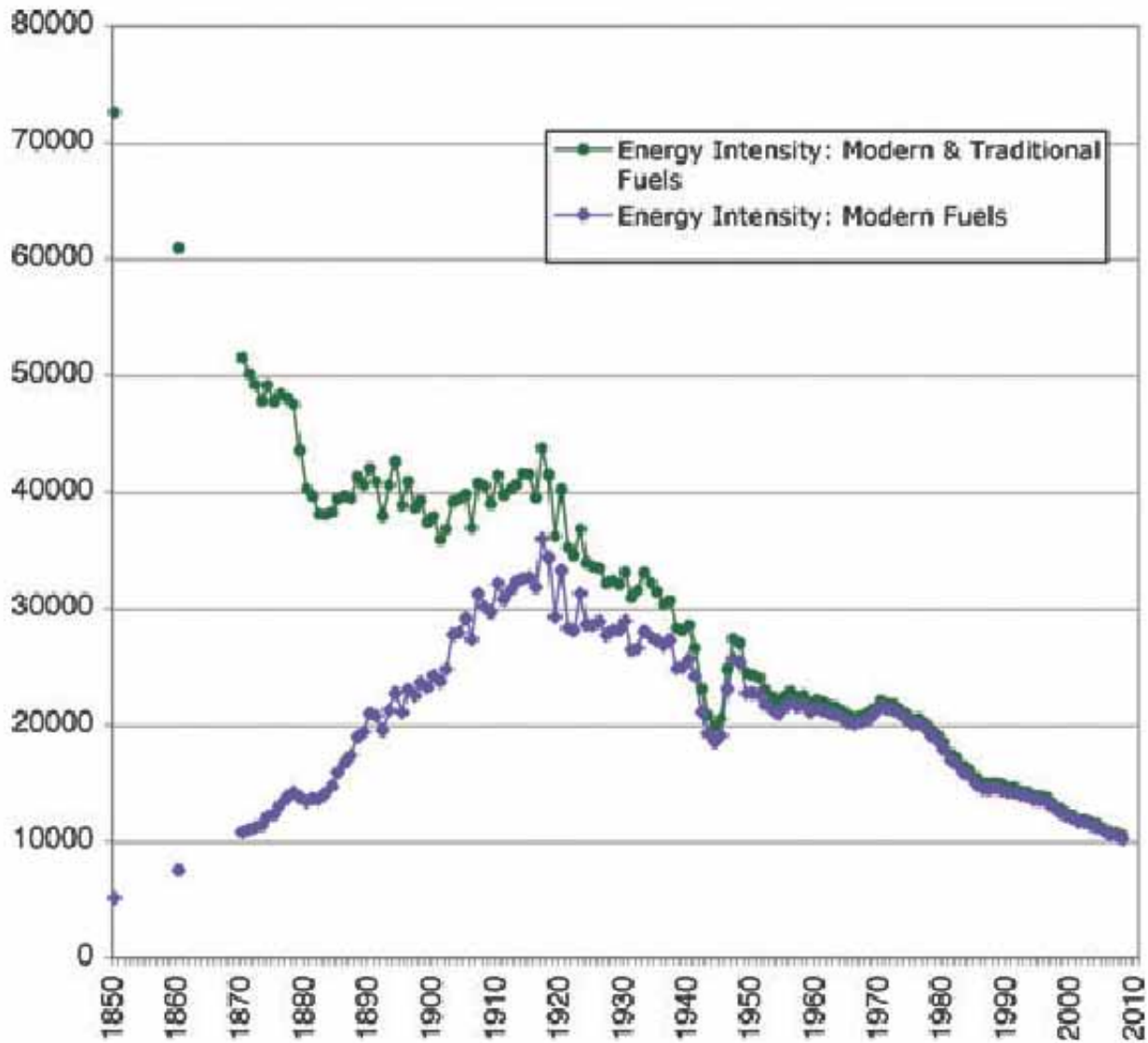
World Energy Intensity



Energy Intensity & GDP per Capita



U.S. Energy Intensity 1850-2008



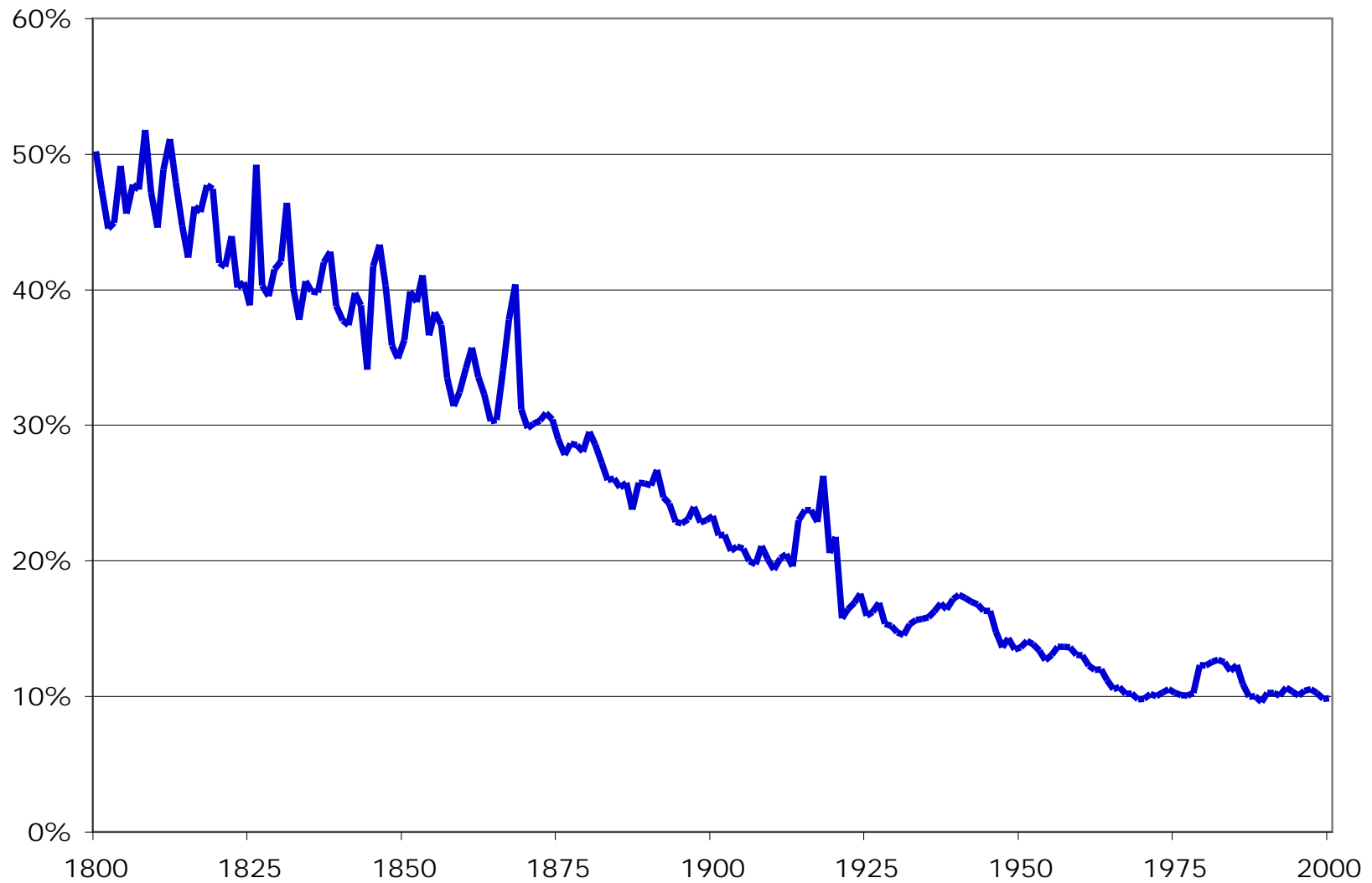
6

The energy cost share declines over time

Energy & Growth:

The Stylized Facts

Sweden 1800-2000 Cost Share of Energy



Energy and Long-Run Economic Growth

Lund U.



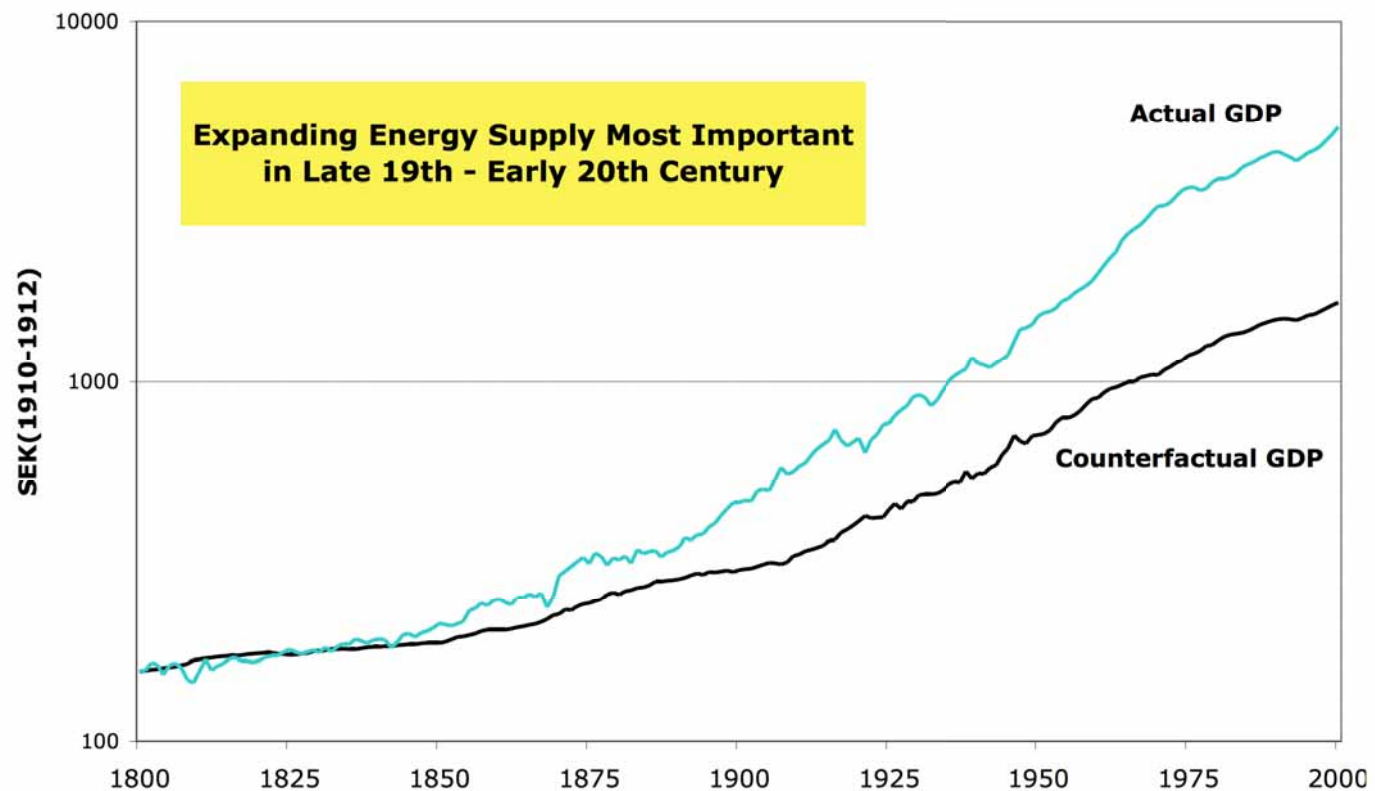
Astrid Kander



Kerstin Enflo

- 200 years of Swedish energy and economic data
- Econometric economic growth model
- Counterfactual simulation and growth accounting

Counterfactual: Constant Energy



Energy & Capital-Labour CES Production Function

$$Y = \left[(1 - \gamma)(A_L^\beta L^\beta K^{1-\beta})^{\frac{\sigma-1}{\sigma}} + \gamma(A_E QE)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

Y = Gross output

L = Labour

K = Capital

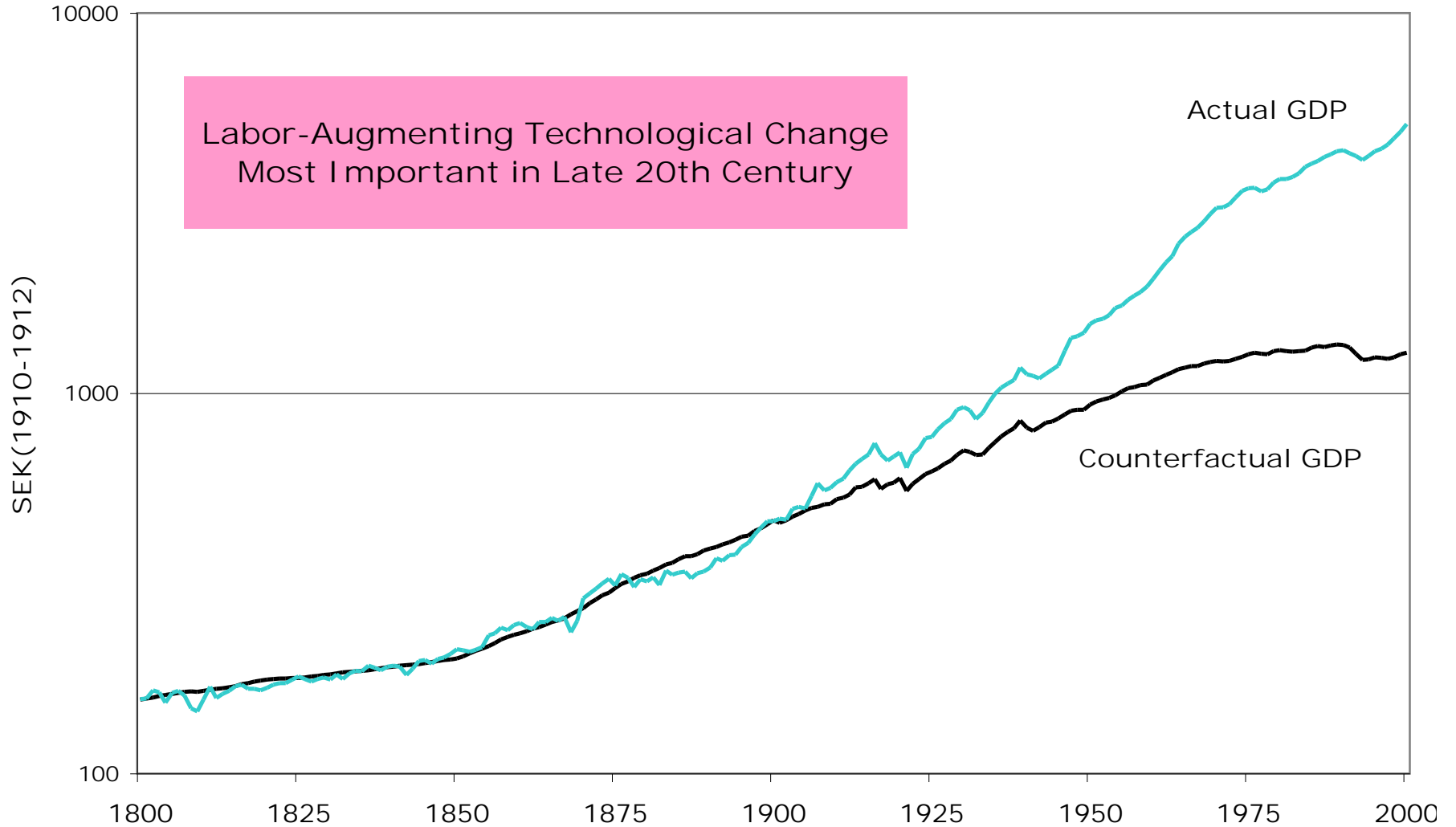
E = Energy (Joules)

Q = Energy quality

A_L = Index of labour-augmenting technological change

A_E = Index of energy-augmenting technological change

Counterfactual: Constant Labor Technology



Energy & Growth: The Stylized Facts

- Energy use per capita increases over time
- Energy use per capita increases with GDP per capita
- Energy intensity is not correlated with GDP per capita
- Energy/capital is negatively correlated with GDP per capita
- Energy intensity declines over time
- The energy cost share declines over time



Kander's Stylized Facts

- Convergence to 3 in capital/GDP ratios
- Machinery increases more than capital and GDP
- Useful work/GDP follows inverted U
- Energy/capital falls over time
- The energy cost share declines over time
- Energy quality increases over time
- Energy intensity falls and converges



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More information:

<http://stochastictrend.blogspot.com>

<http://www.sterndavidi.com>