

THE RELEVANCE OF ENERGY ACCESS REGARDING INCOME INEQUALITY

Research question

Which impact does the historic development of energy access has on economic development opportunities? According to Roland Coase, no matter who the "first" owner of the resources is, a well-shaped market allocates the resources to those who use it most efficiently. However with huge differences in spending power, it's questionable whether the oil is used more efficient in a sport utility vehicle than for irrigation on a poor farmers field.

Why did the industrial revolution start in the West? According to Robert C. Allen it was the low population density of North America that promoted the mechanization and industrial revolution in Great Britain. In the dense populated China, it was of no use to invent labor saving farming techniques - it would just result in unemployment. Wages were low in China and land was rare. While in North America, the available land per workforce was abundant, and therefore, the marginal cost of labor resp. the salaries were high. The following graph might illustrate the process of development:

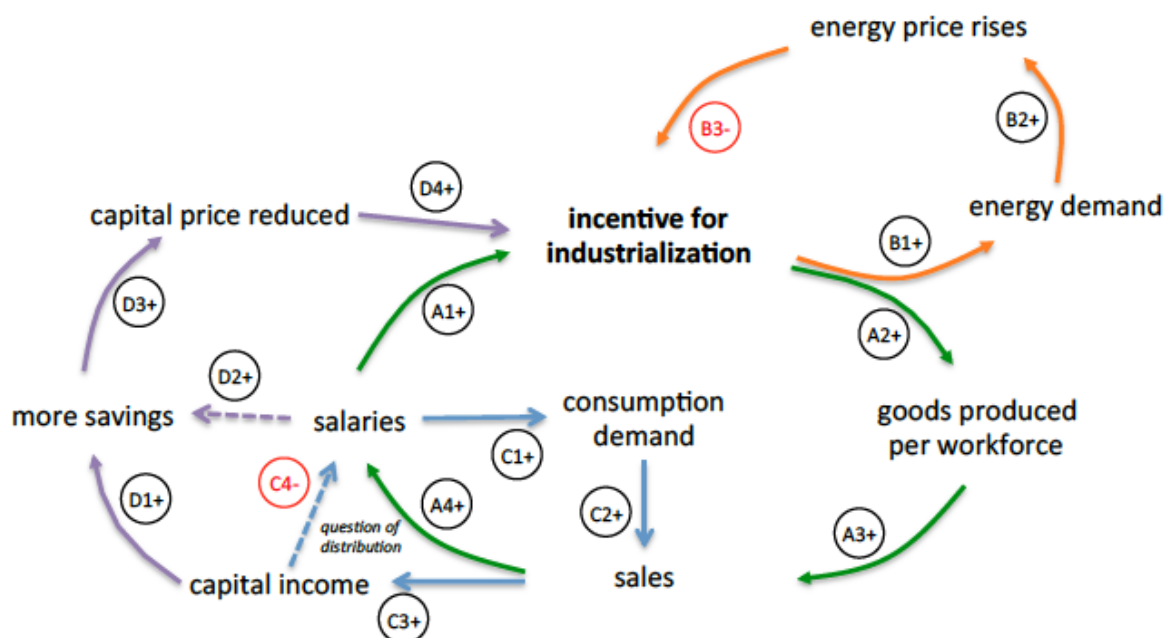


Figure 1: system interrelation for economic development (own design)

There is a cumulative cycles for growth: The mechanization resp. industrialization triggered in North America increased the goods produced per workforce. This increases sales, which are split into salaries and capital income - provoking the question of distribution. Higher salaries give even more incentive for industrialization, as does a reduced capital price due to more savings. The prerequisite to maintain growth is that the consumption demand grows to cover sales; therefore maximizing capital income would threaten growth.

There's a breaking loop (in orange), too: Industrialization increases energy demand, leading to higher energy prices. However the energy price related to salaries is low in western countries because industrialization there started early and locally. It is out of touch with reality but relevant when thinking towards a balanced industrialized world: If industrialization would have started uniformly over the globe, the industry might not have reached the energy intensive level of today, as the scarcity and price of energy would have reduced the incentive for further industrialization.

As global income inequality and a global oil price level emerged, the cumulative cycle also works towards the opposite: In an underdeveloped country with high capital and energy cost compared to labor cost, there's no incentive for industrialization. The exception is industrialization for export, bringing cheap labor on the global market, as China does. Therewith, the income distribution question becomes global and is closely related to the history of energy access. The following question would be how a world with similar energy access to everybody (and less inequality) for would look like - the accessible energy volume cannot be multiplied without renewable sources - and which path might lead there.

Modeling

The "incentive for industrialization" means that an investment in mechanization is profitable. An investment (I) is profitable if

$$I \leq \int_0^{\infty} \frac{G_I - G_0}{(1+i)^t} dt$$

Whereas

$$G_I = \text{profit with the investment} = S - wL_I - p_{eI}E - V$$

= Sales - wage x labor - energy price x energy quantity - pre-products

and

$$G_0 = \text{profit without the investment} = S - wL_0 - V$$

In a simplified model, we can say (for one individual manufacturer) that sales and pre-products remain constant and the energy quantity before the mechanization investment was zero, while the number of laborers decreases and with more energy quantities used, the energy price rises.

Therewith,

$$G_I - G_0 = w(L_0 - L_I) - p_{eI}E$$

To exclude unemployment, on a national level, $L_0 = L_I$, while the production resp. sales volume goes up. Therefore, I suggest to replace $L_0 - L_I$ by a percentage (%) of labor saved per production volume. (Whether the sales price per good drops, depends on the price elasticity...) Anyway it is obvious that the sales output per laborer (S/L) is higher after the mechanization investment than before. Growing sales means growing gross domestic income. On the short run, the wages w doesn't have increase: the capitalist can turn all the benefit of his investment into his capital income (C3+). If the capitalists turn their capital income into more savings, the price for capital (interest rate i) goes down, so investments, which were not profitable at high interest rates, now become profitable too. With more and more investments, finally an increasing production volume is looking for consumers. For some time - as in the "belle époque" - a class of wealthy capitalists can come up with enough demand to consume the industrial output. However two factors are pushing towards higher wages: Not only the risk of social unrest due to enormous income inequality, but also the necessity to open up a broader purchase power to consume the fast growing industrial production. Because if the production doesn't turn into sales there's no profit on the investment. If w grows, this is not only enjoyable for the laborer; high wages also foster the incentive for industrialization.

$$I \sim \frac{w(\%l) - p_{el}E}{1 + i}$$

So far, we were looking at one national economy where the industrialization took off. Instead of strengthening the domestic purchase power with higher wages, selling to foreign (colonial) markets was another strategy to turn production into sales. With more labor required for a good in a non-industrialized (colonial) nation, the industrialized supplier can offer the good cheaper. Respectively the wage in the non-industrialized nation has to decrease to remain competitive to the imported industry goods. Now this might explain the start of the "great divergence" resulting in the huge global income inequality observed today. (Does this correspond to common theories?) Anyway the role of energy remains to be explained. It's obvious that one can afford more energy with a higher income - however a high energy consumption can also be seen as a prerequisite to achieve high incomes. (The western nations discovered and took possession of the oil fields in the colonial area.)

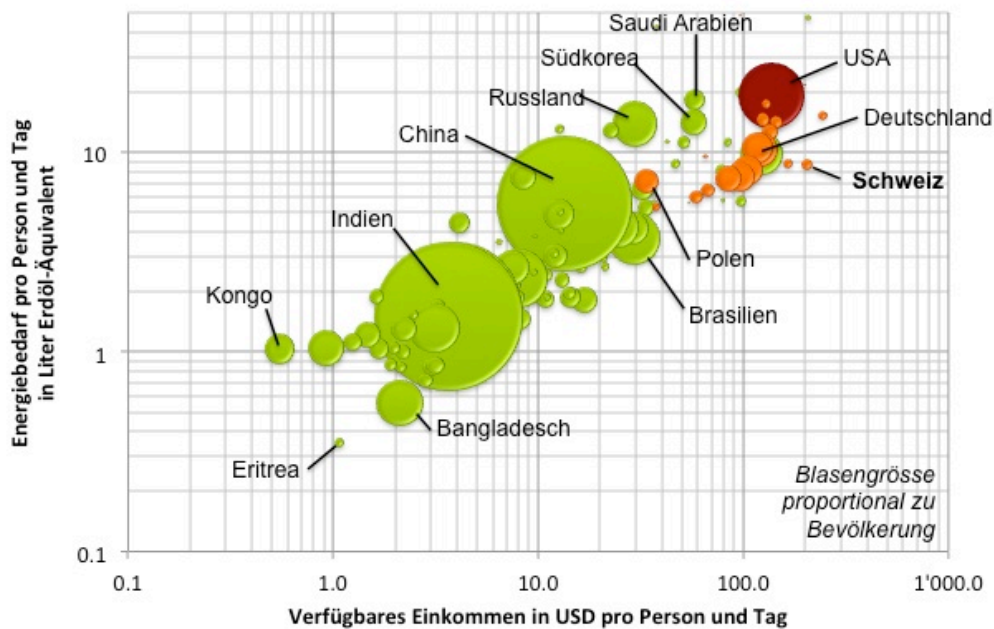


Figure 2: correlation between energy consumption and income (own chart with data source: worldbank 2011)

My starting point is the hypothesis that renewable energies are crucial to reduce the gap between so called industrialized and developing countries. To verify this, let's assume that energy can only be gained from limited natural resources - as coal, oil and gas dominated which dominate energy supply of today.

		nation on industrialization path					
		w	%l	pe	E	i	I
high wage in north america due to "free land"	t0	10	20%	1	1	10%	0.91
capital price reduced due to high saving rate	t1	10	20%	1	1	5%	0.95
keep sales growing by higher wages and export	t2	15	20%	1	1	5%	1.90
energy price rises due to high energy demand	t3	15	20%	1.5	1	5%	1.43

low wage country, missing the industrialization path						
	w	%l	pe	E	i	I
t0	5	20%	1	1	10%	0.00 not attractive to industrialize
t1	5	20%	1	1	5%	0.00 not attractive to industrialize
t2	4	20%	1	1	5%	-0.19 even less attractive to industrialize
t3	4	20%	1.5	1	5%	-0.67 even less attractive to industrialize

Expected results

Without renewable energies, any wealth gain in developing countries leads to more competition on limited energy resources; in consequence, the energy price must rise (leading to impressive scarcity rents for the current owner of the resources). If a big country like China can reduce its income backlog by an aggressive competitive export strategy maybe turning into a domestic consumption development, one can think of a scenario where w_{China} goes up from 4 to 12. If the Chinese income triples, a doubling of the global energy price might result due to the enormous increased energy demand. Out of the Chinese perspective, the energy became cheaper relative to the income - fostering even more energy consumption. While a doubled energy price at constant income levels in Europa and the USA - combined with cheap imports vanishing - might challenge the currently energy-blessed wealth-society. With growing resource shortage, skyrocketing energy prices make investments in energy intensive industries unprofitable worldwide - while wars on resources can become profitable investments.

development with limited energy resources							development with renewable energies						
	w	%l	pe	E	i	I		w	%l	pe	E	i	I
t4	12	20%	2	1	5%	0.38	t4	12	20%	2	1	5%	0.38
t5	12	20%	2.5	1	5%	-0.10	t5	15	20%	2	1	5%	0.95
t6	12	20%	3	1	5%	-0.57	t6	15	20%	1.5	1	5%	1.43
t7	12	20%	3.5	1	5%	-1.05	t7	20	20%	1	1	5%	2.86
<i>destroys industrial capital of</i>						<i>-1.33</i>	<i>justifies investments up to ...</i>						<i>5.62</i>

To become independent of the globally rising energy price, the renewable energy industry is the promising sector to turn domestic labor into the future power required to maintain wealth. (In the renewable energy scenario, rising labor demand leads to higher wages, and energy price falls due to abundant renewable energy.) Energy access is not the only but a relevant factor explaining global inequality. (Without income inequality, the standard of living of a small portion of mankind couldn't have become so energy intensive - and luxurious - at all.) Energy is the factor that has to be opened up - with renewables - otherwise the development of poor nations could only come with a fall of the rich nations. Rich nations can make use of their power to defend their privileges; anyway supporting renewables and learning to live without cheap imports (resulting from a history of colonial expansion) is the less convenient but on the long run more stable path.

The drafted model and expected results here are only a preview on more work to be done. I wonder whether other researchers work in a similar direction. It would be my pleasure to write a scientific paper on this topic.

Henry Lüthi, December 2016