

Knowledge and Growth

We live in a world of ever deeper contrasts. While North American children get to enjoy a new and much improved videogames console every 16 months, Mozambique's kids get to play with same trash tin technology that already entertained their grandparents, decades ago.

Of course that North America, Mozambique, and the entertainment technology are just examples, and that not all the entire population fits the scenario. But maybe it's a good enough example of the huge differences between countries sharing the same XXI century.

How economies grow is an important question. In 1957, Robert Solow presented a mathematical model showing that sustained economic growth depends largely on technological advancement. Solow's model assumes a production function (Y) that measures output from the variables capital (K) and *effective labour* – a term that combines the inputs knowledge (A) and labour (L).

Solow's model doesn't explain technological change, but states that only technological progress can have growth effects; this is why it is labeled as an exogenous technological change growth model.

This is a diminishing returns model, meaning that, over time, output is expected to decrease. The rate of growth of output per capita and the rate of return on investment are expected to decrease, as capital stock increases. This makes sense to some extent: after all, any equipment a firm buys today will be worth less money tomorrow, the same way people (human capital) tend to have a performance peak on their early lives.

As a consequence, on the long run, thinking in aggregate terms, for different countries, wages and K/L ratios will converge, shadowing the relevance of the initial conditions and whatever might happen along the road... and that doesn't make much sense, for what reality shows looks like more the opposite.

If we think on feedback mechanisms, diminishing returns can be seen as a healthy or negative one: if something pushes in one way, something else pushes the opposite (negative) way, towards a homeostatic (equilibrium) state. The term "healthy" comes from Medicine, for when there is a disease, the body fights against it. Unfortunately, economies aren't that self-regulatory – Adam Smith's invisible hand might not exist.

For many countries, what data shows is a positive feedback trend. The rich get richer; the poor get poorer. The increasing returns of the so-called developed countries contrasts with the increasing difficulties of the so-called third world.

The problem with diminishing returns models might be the non tangible assets, and today's economies strongly depend, more and more, on such ethereal goods...

On Solow's production function – $Y(t)=F(K(t),A(t)L(t))$ – the *effective labour* factor, implies that knowledge only directly affects labour. Relating

this with Keith Smith's papers on "the Knowledge Economy", it emerges the feeling that knowledge is not fully accounted. Knowledge is also present (incorporated) in physical assets, and it is codified on broadly spread knowledge bases which are some of the consequences of its public good characteristics: nonrivalous and partially nonexclusive consumption¹.

The fact that knowledge has these attributes, makes it accumulable per capita without bond (since the exact same knowledge can be shared among millions, across time) and hard to contain, making it easy for spillovers and positive externalities (for example, the knowledge bases).

A number of endogenous technological progress theories try to explain long run growth, capturing technological change as a consequence of growth itself (endogenous growth). Paul Romer's model (1986 and 1990) is one of such efforts.

With Romer's model it is possible for output per capita to grow without ceiling, and for the rate of investment and the rate of return on capital to increase, with increases in capital stock. It's an increasing returns (in the production of output) model, focused on knowledge – the "new" basic form of capital.

Contrary to physical capital, knowledge can have an increasing marginal product (the more you input it, the more the production function outputs, hence the increasing output returns), but of decreasing returns in the production of itself (one can't expect, for example, to always double research and to always double the acquired knowledge; that is, ever greater research efforts will be required to ever smaller gains, and this is the root for the expression "Knowledge Economy", such is the relevance of knowledge²).

Romer considers the hardly avoidable externalities of knowledge, the increasing returns in the production of output, and the decreasing returns on the production of new knowledge, to be the pillars of his model of growth.

Innovation, in the sense of knowledge as a new product or as a new process, is the key to economic growth. The problem is how to keep innovating, since an eventual success will tend to push the firm towards improving the efficiency of what they just did so well. However, if the initial trend is not lost and the firm sustains it, avoiding just diversifying its products, it might open the road to sustained increasing returns, hence the importance of its organizational culture.

In other words, true innovation should not lead to price-taking behaviour or price wars, since it refers to something unique. Plus, in order to keep on track and make it possible for future innovations, the current products should be priced accordingly.

¹ On the words of Thomas Jefferson, third president of the USA: "he who receives an idea from me, receives instruction himself without lessening mine; as him who lights his taper at mine, receives light without darkening me...".

² The relevance is greater, the more developed the country; such is the efficiency of its production, requiring higher and higher knowledge for any improvement.

Because of the high costs of R&D, countries try to protect the firms' investments, via mechanisms like patents and copyright laws. Such mechanisms fight the natural nonexclusive nature of knowledge, and can pose the delicate problem of social costs. For example, a long run patent can delay the public benefits of some new product, or even delay innovations of higher importance, that would have been possible, should the patent have a shorter life span.

These mechanisms should be regarded as incentives, but firms should be aware that the increasing returns can only be sustained with the next innovation.