

Chapter 9: Cutting-edge of technology

New technologies, which are just developed and in production, are referred to as **Cutting edge of technology**. It has the nature of wearing off rapidly- former cutting-edge technologies like the telegraph and replace with new cutting-edge technology, e.g. the mobile phone.

Historical overview

- *Technological progress before the 18th century*

From A.D. 500 to 1500, income per capita in Europe did not grow at all. The population only grew at a rate of 0.1% during this period. The value of A rose with 1.39. In the period after this from 1500-1700, there was a fast increase of economic growth in Europe. Both income per capita and A rose. But still these growth rates of productivity were extremely slow compared to growth rates in the world today.

- *The industrial revolution*

The **Industrial Revolution** is dated between 1760 and 1830 in Britain with major and rapid technological progress within a wide range of sectors, including agricultural, manufacturing (e.g. textiles), metallurgy (coal as source for fuel for steam power) and energy (e.g. steam engines). This revolution was the most significant turning point in the history of technological progress.

The rapid technological change spread to the rest of Europe and North America and led to an accelerated increase of the average income of the broad population. Moreover, the structure of the economy changed; the share of the labour force employed in the agricultural sector decreased sharply and increased in the industrial and mining sector. That came along with a change in the living structure; for the first time, the major part of the population lived in cities. On the other hand, Britain faced a rather slow (compared to nowadays standard) GDP growth rate of only 0,5 % during the Industrial revolution and growth did not stop after 1830, the end of the British revolution. GDP growth rate was limited due to the fact that the industrial revolution was constraint to few industries.

- *Technological Progress after the industrial revolution*

In the period after the Industrial Revolution, the US economy overtook Britain and became the new world leader in advanced technologies and in GDP per capita. Two trends are noticeable during that remarkable period; first the transformation of the daily life technologies reached new levels; the invention of the electronic light bulb, automobile, refrigerator, telephone, aviation travel or TV changed the daily life substantially. It took several decades for the new technologies to spread over the world, a process that is known as **diffusion**. The second phenomenon is the **productivity slowdown** starting around 1972 in the developed world. After the long period of incomparable productivity growth it finally slowed down.

The technology Production function

Please recall the “normal” production function we dealt with in Chapter B; a function which relates input factors used (capital, labour) with the resulting output. Instead of the output produced in an economy, the output of the **technology production function** is new technologies created and the inputs include labour and human capital (researchers) as well as capital (laboratories, computes).

We will use the following equation:

$$\hat{A} = (L / \mu)$$

The main concern is that the inputs in the productivity function have grown substantially (in the factors of Capital and Labour), whereas the growth rate of technology has not.

Fishing out effect. "Fishing out" because researchers are having difficulties to fish a "big fish" out of a small pond, because all easy inventions (big fishes) have already been caught. That is due to the accumulateness of knowledge; researchers do not only have a broader base of already-existing knowledge, but it also takes more effort for researchers to acquire all relevant prior knowledge, in addition to the difficulties of the fishing out effect, that all easy inventions are already made. The technology production function above does not take into consideration the past. But with the information, that "L" inputs rose over the last years

significant and the information that \hat{A} stayed constant or even decreased, points at an

additional factor influences the rate of technological growth (e.g. fishing out effect), which is not explicitly listed in the technology function.

Another aspect, which we have to assess with the production formula above, is the **decreasing returns to scale** in technology production. The formula implies that the production of technologies have a constant return to scale, i.e. if you double the amount of R&D workers, the technology produced should also double. That assumption however is not realistic; devoting more R&D effort might lead to parallel invention, that is two or more developer (teams) are working on the same task, but only the first one to finish will gain the patent. Therefore, more effort in R&D will not lead to a constant return, but rather a diminishing return to scale in technology production.

General purpose-technologies will have a massive, far-reaching impact on the local economy and will change it substantially, like the steam engine or electricity networks.

Moore's law (after G. Moore, a founder of Intel Corporation) stated in 1965 that every 18th month the power of Intel processors will double which held to be true up to today. The importance of that law is that G. Moore succeeded to predict the technological pace of new technologies during a time at which computers did not seem to have such an impact.

Differential Technology Progress in different sectors

Technological progress pace might vary substantially across different sectors. The differences between rapid changing technology industries, like communication and slow changing sectors e.g. teachers is reflected in the relative price of goods. Goods that encounter a lot of productivity growth are relatively cheaper than slow growing technology goods. That relationship can also be seen when comparing goods versus services.

The production technologies for goods developed most rapidly in the economy, whereas the technology progress in service sector grew little over time. Therefore, according to the differential production ratio (i.e. price for goods / price of service), service is relatively more expansive. Unfortunately the trend of consumption also changed over time; The People's consumption (in this case in the U.S) of services rose extremely in the 2nd half of the 20th century, which increases the total expenditure, since the services increased in price. That

shift of expenditures, i.e. increase of service demand and relative increase in service price is called the **cost disease**, first discovered by the economist William Baumol.