Sustainability, innovation and finance: integration challenges

edited by
András Bethlendi – László Vértesy

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Sustainability, innovation and finance: integration challenges

This book aims to provide an introduction to the main characteristics of the innovation and green financing promoting sustainable developments.

Both innovative and green activities are phenomena with positive externalities and are, among other things, characterized by underfunding. The state, the regulator, has a significant role in boosting innovation and green ecosystems as well, including funding systems. Besides, green things are often innovative; therefore, they are a subset of innovative, creative companies/activities. The discipline is currently fragmented into the following: innovation macro- and microeconomics; sustainability studies macro and micro (e.g. SCR) level, innovation (corporate) management; innovation finance systems (crowdfunding, venture capital) and green approaches. The text tries to integrate the different approaches and methods, which would give it a novelty.

Before a detailed discussion of financing issues, it is indispensable to clarify the role of innovation and sustainability play in economic and management thinking. It is worth examining those aspects in which these domains/fields of economics are different from the traditional functioning of the economy and industries and why they deserve special attention from a macroeconomic and social point of view. Furthermore, the relationship between the government and the market and the role of the government give rise to an essential professional debate. The integration of finance and sustainability is not a conflict-free situation.

The Editors

I. Innovation

Árpád Szőcs

1. Trends, models and ecosystems

In this chapter, the essential terms are Innovation and R&D interpretations, risks, common goods versus private goods, external effects, Innovation ecosystems (USA, Israel, China).

In the ongoing global economic race, all nations are looking for the Holy Grail that can ensure their competitiveness. Given the different historical backgrounds and regional characteristics of each country, it is difficult to make a sure recipe for everyone. However, the important role of innovation is recognized by economic decision-makers. The following are three countries that have been successful in developing their innovation ecosystems and play a key role in the international economy. The US, Israel, and China models also contain elements that are worth reviewing and analysing. The following is an overview of the historical development and experience of these countries in building their innovation ecosystem.

1.1. USA

In just over a hundred and fifty years, the US innovation ecosystem has become a model for the world. The practice-oriented approach, the economic policy is supporting innovation, the higher education is cooperating with the corporate sector, and all the factors that contributed to its success. Within the US innovation ecosystem, the relative importance of the main actors (universities, large corporations, and small science-based start-ups) has changed over time. Government policy also plays a powerful enabling role in determining innovation success through the broad areas of trade, tax and regulatory policy that shape the innovation environment. The U.S. system of intellectual property protection has its roots in the U.S. Constitution, which gave Congress the powers to promote "the progress of science and useful arts" by providing inventors with the limited but exclusive right to their discoveries. The US economic and political decision-makers have learned that innovation and its protection are essential elements of economic success. In light of all this, the current conflict between the United States and China can be regarded as a technological war rather than a trade war.

1.1.1. A historical perspective

From the 1870s, the United States has risen from a relatively backward position in science and technology to an area of undisputed pre-eminence[1]. The development of the American innovation ecosystem can be divided into three main periods:1870s-1945, 1945-1980s, and 1980s-to date.

In all three periods, the actors that were the drivers of innovation can be identified. From the second half of the 1800s, American universities were centers of practical knowledge for the local economic environment. An important advantage of the American innovation environment over Europe was that it was available in a kind of "greenfield." It was not influenced by previous pre-industrialized systems.

World War II demonstrated the practical applications of science to the military and industry in many areas. After the victory, it was possible to increase research funding. By the mid-1960s, American universities enjoyed a world-leading status in most fields of science. Enhanced university research environments and rising subsidies have also encouraged large companies to increase their R&D activity. Corporations such as AT&T, Merck, Kodak, IBM, and Xerox subscribed to the view that research was the key to growth. They employed thousands of scientists whose chief objective was to conduct research[2].

From the 1980s, the contribution of large firms to research and innovation declined, and the contribution of small firms rose. NSF data indicate that firms with more than 10,000 employees accounted for 73 percent of non-federally funded R&D in 1985. By 1998, this share had dropped to 54 percent, and 51 percent by 2008.[3] The role of smaller businesses was strengthened by the fact that the entire US economy was shifting from "manufacturing" to high value-added industries. IT, biotechnology and pharmaceuticals have provided opportunities for smaller start-ups in a large number to enter R&D activities and serve the needs of large companies independently.

[1] Arora, A., Belenzon, S., & Patacconi, A. (2017): The decline of science in corporate R&D. Strategic Management Journal, 2693.
[2] Aurora et al. (2017): i.m.
[3] Mowery, C. (2009): Plus ca change: Industrial R&D in the “third industrial revolution”. Industrial and Corporate Change, 1-50.

1.1.2. Main elements and players

As a result of historical development here are three main factors in the US innovation ecosystem

- universities and other public research institutions,[4] such as the Federal labs and the National Institute of Health
- large corporations and their corporate labs, and
- individual inventors, small firms, and science-based start-ups.

As Christopher Freeman defined it, a national innovation system is "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."[5]

Federal Labs and university research

The United States funds a system of between 80 to 100 government research laboratories, and the largest labs are funded by the departments of Defense, Energy, and Health. Research is mainly funded to help these agencies to achieve their mission goals.

The Defense Advanced Research Projects Agency (DARPA) and Advanced Research Projects Agency-Energy (ARPA-E) have also played an important role in the US innovation ecosystem. DARPA has held to a singular and enduring mission: to make pivotal investments in breakthrough technologies for national security. The genesis of that mission and of DARPA itself dates to the launch of Sputnik in 1957, and a commitment by the United States that, from that time forward, it would be the initiator and not the victim of strategic technological surprises. University research is supported through agencies like DOD (Department of Defense), DOE (Department of Energy), and NIH (National Institutes of Health), to help them achieve mission goals, and the National Science Foundation funds university research largely unrelated to agency mission goals. While the system is based on the conception of the

[4] The education sector itself is a target of venture capital market, educational technology (Edtech) startups attract increasing investments. Bethlendi András, Szőcs Árpád (2019): IKT startup-ok pénzügyi kérdései. Információs Társadalom, 19 (3).

[5] Freeman, C. (1987): Technological infrastructure and international competitiveness. USA: OECD.

linear model of research, some argue that federal funding for university research should take a more explicit account of the needs of the commercial economy and promote tech transfer[6].

Corporate labs

An advantage of large corporate labs is that they can organise their research by a problem or a market demand, rather than by discipline, the approach generally taken by universities. Within the US innovation ecosystem, the relative importance of the main actors (universities, large corporations, and small science-based start-ups) has changed over time. Large firms can either grow through internal research carried out inside their labs, or commercialize inventions created by start-up partners. Besides, in the past decades, new technology firms funded by venture capital, have become prominent in many sectors[7].

Individual inventors, small firms and science-based start-ups

An important class of small firms is VC-backed start-ups. Venture capital (VC) partnerships finance a very small minority of all new firms - about 1/6 of 1% on average per year in the US[8]. Nevertheless, VC-backed firms feature disproportionately among the fastest growing and the best-performing companies. In the US, from 1999 to 2009, over 60% of IPOs originating from industrial start-ups received VC funding. VC-backed firms are also distinctive innovators. On average, a dollar of venture capital results in three to four times more patents than a dollar of traditional corporate R&D, indicating perhaps superior efficiency in the invention, but also perhaps a greater focus on product, rather than process, the invention by VC-backed start-ups[9].

1.1.3. Influencing factor

Trade, Tax, and Regulatory Environment

Government policy plays a powerful enabling (or detracting) role in determining innovation success through the broad areas of trade, tax and regulatory policy that shape the innovation environment. Compared to other nations, the U.S. regulation system erects few barriers to entry for firms to break

[6] Atkinson, R. (2014): Understanding the U.S. National Innovation Systeem. USA: The Information Technology and Innovation Foundation.
[7] Aurora et al. (2017): i.m.
[8] Lerner, J. (2012): The architecture of innovation: The economics of creative organisations. Cambridge, MA, USA: Harvard Business Review Press.
[9] Kortum, S., & Lerner, J. (2000): Assessing the contribution of venture capital to innovation. Rand Journal of Economics, 674–692.

into existing markets and relatively easy to start a new business (World Bank index). The U.S. corporate tax rate is quite high (in both statutory and effective terms), besides the R&D tax credit is relatively anaemic compared to other nations. Furthermore, the United States is also one of the very few nations that do not use a border-adjustable value-added tax (VAT)[10].

Intellectual Property

The U.S. system of intellectual property protection has its roots in the U.S. Constitution, which gave Congress the powers to promote "the progress of science and useful arts" by providing inventors with the limited but exclusive right to their discoveries. This applies to copyrights and patents, with trademarks similarly protected by Congress under the Commerce Clause (Article I, Section 8, Clause 3). The view then, as well as now, is that without reasonable protection for their IP, individuals and companies would innovate and create less. Patents and trademarks are governed by the U.S. Patent and Trademark Office (PTO) in the Department of Commerce. Copyright is governed by the Librarian of Congress. Moreover, of course, Congress writes the laws under which these agencies must function, and mostly objective courts can rule on their decisions[11].

1.1.4. Systems of knowledge flows

Technology Transfer Systems

Before the 1980s, technology transfer (from universities or federal labs to the commercial marketplace) was largely an afterthought, at least as far as the federal policy was concerned. To be sure, some institutions, like MIT and Stanford, had long played an essential role in working with industry and supporting new business spin-offs. However, such efforts were primarily due to unique institutional factors and were not widely adopted by publicly supported research institutions. In 1980 the Congress passed the Stevenson-Wydler Technology Innovation Act. The legislation stated that "technology and industrial innovation are central to the economic, environmental, and social well-being of citizens of the United States."

The Act made several changes to enable better the transfer of technology from federal laboratories to commercial use. Likewise, the Bayh Dole Act changed the intellectual property rules governing federally funded research at universities, allowing universities to retain IP rights, giving them more

[10] Atkinson (2014): i.m.
[11] Atkinson (2014): i.m.

incentive to commercialize research. Congress also passed the Federal Technology Transfer Act of 1986, and Competitiveness Act in 1988 (that among other things created the Technology Administration in the Department of Commerce and created many programs to help industry with innovation). Besides, some agencies, like NSF and NIH, have begun pilot programs to link their funded research to commercialization outcomes better. Overall, while policies have been put in place to help spur commercialization, the only federal agency explicitly focused on commercial innovation is the National Institute of Standards and Technology[12].

Innovation Clusters

Clusters have been found to increase the innovation levels, efficiency, and productivity with which participating companies can compete, nationally and globally[13]. The concept of innovation clusters has been long understood by regional planners. In the 1990s, many governments in the United States began to focus more explicitly on spurring innovation clusters. Clusters are geographic concentrations of interconnected businesses, suppliers, and associated institutions. They can contain anchor institutions, small firms, start-ups, business incubators, and accelerators[14]. The emergence of a few high-profile clusters such as Silicon Valley and North Carolina's Research Triangle Park (RTP) lent credibility to the notion that innovation clusters can power innovation and growth. Nowadays, many U.S. states have innovation cluster programs and policies[15].

Industry Collaboration Systems

Compared to many other nations, the United States has a highly developed and successful industry-research institute collaboration system. Universities like MIT, Cal Tech, and Stanford are models that the rest of the world, and indeed, other universities in America, look to for inspiration. There is no single reason for U.S. success at university-industry collaboration; rather, several factors play a role. One factor is culture. A long tradition of John Dewey-

[12] Atkinson (2014): i.m.

[13] Porter, M. (1998): Clusters and the New Economics of Competition. Harvard Business Review.baily

[14] Baily, M., & Montalbano, M. (2018): Clusters and Innovation Districts: Lessons from the United States Experience . USA: Economic Studies at Brookings.

[15] Stewart, L., & Atkinson, R. (2012): The 2012 State New Economy Index. USA: Information Technology and Innovation Foundation

like pragmatism has dominated U.S. universities, leading them to view collaboration with industry not as something that sullies the purity of basic research, but rather as something that is useful and can advance knowledge.

Also, the U.S. system, with a diversity of kinds of universities and ownership (with a large number of world-class private universities), has created a more competitive environment where universities innovate and compete to work with industry. On top of this, U.S. universities are much less hierarchical than universities in many nations, where faculty must wait until they become full professors to work with industry or start new companies. Finally, in many states, public colleges and universities are encouraged and supported by state and local governments in their efforts to work more closely with industry. Despite this overall positive record, it is important to note that there is still considerable diversity in commercialization performance. For every MIT or Stanford, there are ten universities where commercialization is more haphazard and less effective[16]. The National Science Foundation's Engineering Research Center (ERC) and Industry/University Cooperative Research Center (I/UCRC) programs have also played a role in facilitating university-industry collaborative research into complex engineered systems[17].

Acquiring Foreign Technology and Exporting U.S. Technology

In part because the U.S. economy is so large and because it generally is at the leading edge of technology development, there has been little explicit policy directed at acquiring foreign technology. The general policy approach has been to welcome inward foreign direct investment because of the technology transfer that it brings. To the extent that the government supports inward FDI attraction, that support has been at the state and local levels. For example, in the 1980s and 1990s, states aggressively courted Japanese automobile company investment in part for the jobs they provided, but also because of the technology transfer that occurred as U.S. auto firms were more easily able to learn the Japanese system of auto production. However, more recently, the Obama administration has established the Select USA, a small initiative in the U.S. Department of Commerce designed to work with the states to help attract foreign investment.

Besides, the United States monitors foreign acquisitions of U.S. companies through the Committee on Foreign Investment in the United States (CFIUS).

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[16] Singer, P. (2014): Federally Supported Innovations: 22 Examples of Major Technology Advances that Stem from Federal Research Support. USA: The Information Technology and Innovation Foundation.

[17] Atkinson (2014): i.m.

CFIUS is an interagency committee authorized to review transactions that could result in control of a U.S. business by a foreign entity ("covered transactions"), to determine the effect of such transactions on the national security of the United States. In part, this reflects a belief that foreign acquisitions of U.S. firms can, in many cases, provide needed injections of capital, know-how, and market access that can help the U.S. establishment become more competitive.

Concerning exporting technology, there are few limits on exporting U.S. commercial technologies to other nations, unless those technologies have potential benefits for current or potential military adversaries. As a result, the Department of Commerce's Bureau of Industry and Security oversees the transfer of certain sensitive U.S. technologies to some foreign nations. However, again, the number of technologies covered is relatively small. Moreover, in the past decade, there has been increasing pressure from industry and others to reduce the restrictions to boost U.S. innovation competitiveness, in addition to the U.S. government[18].

The role of VC-s

The modern organisational form of venture capital, however, dates back only to 1946. Bank lending rules then (and now) looked for evidence that borrowers had collateral and could make timely payments of interest and principal. Most entrepreneurial firms, however, did not meet these standards, so they required risk capital in the form of equity. There was usually no regular source of such capital, meaning that entrepreneurs without wealthy friends or family had little opportunity to fund their ventures. Along came George Doriot to solve this problem. General Doriot, so-called for his rank in the U.S. Army quartermaster's office during World War II, recognized the need for risk capital and created a firm to supply it. His firm, American Research and Development Corporation (ARD), began operations in 1946 as the first true VC firm. Unlike modern funds, it was organised as a corporation and was publicly traded.

In its 25-year existence as a public company, ARD earned annualized returns for its investors of 15.8 percent.[19] ARD also sets a standard for generating these returns that have persisted in the present day. Excluding the $70,000 investment in their biggest "home run", the Digital Equipment Corporation, ARD's 25-year annualized performance drops to 7.4 percent. Many modern

[18] Atkinson (2014): i.m.

[19] Fenn, George W. Nellie Liang, and Stephen Prowse (1995): The Economics of the Private Equity Market. Staff Studies from Board of Governors of the Federal Reserve System No 168

venture capitalists spend their days searching for their home runs, now with more fanciful names like Yahoo!, eBay, and Google—all firms that started as venture capital investments and made legendary reputations for their investors.[20]

1.2.Israel

Israeli innovation is defined by several dimensions. Technologically, the majority of the innovation activity is focused on the ICT sector. From a geographical perspective, the dominant mass of activity is still concentrated in central Israel, with only relatively low activity even in major cities like Haifa, Jerusalem, and Beersheba. An important feature of the Israeli innovation ecosystem is that the state has a major role to play in funding research activities.

1.2.1. A historical perspective

Today's Israeli innovative, start-up-oriented ecosystem is characterized by continued collaboration between public programs and the private sector, often with novel connectivity solutions[21]. In the early nineties, the Israeli RDI structure underwent a major transformation, rapidly replacing the military-based innovation base with the entry of a Silicon Valley-type system focused on high-tech civilian start-ups and increasingly multinationals. Venture capital played a critical role in the rapid development of the innovation ecosystem, which can be divided into three stages[22].

The pre-90s period is interpreted as the preparatory phase when the Israeli innovation system base was established, and the high-tech structural change took place. The second, initial start-up phase (1991-93), looks at the period when the number of start-up companies and their evident financial difficulties led to the decision to launch public intervention, Inbal and then Yozma. In the third period, the concrete upswing phase (1994-2000) is identified, when the venture capital industry already had billions of resources, deeply embedded in the innovation system, actively contributing to its development.

[20] Metrick, A., & Yasuda, A. (2011): Venture Capital and the Finance of Innovation. USA: John Wiley and Sons.

[21] Turi, M., & Korányi , L. (2010): Innovatív induló izraeli kisvállalkozások fejlesztési modellje, ennek adaptálása Magyarországon . Hungary: Műhelycsoport: EU Modellek 25 .

[22] Avnimelech, G., Schwartz, D., & Bar-El, R. (2008): High Tech Development Policy: Israel's Experience with two Policy Instruments. Beer Sheva, RSA Conference. Izrael: Beer Sheva, RSA Conference.

1.2.2. Main elements and players

Government programs for supporting innovation

An important feature of the Israeli innovation ecosystem is that the state has a major role to play in funding basic research. The Ministry of Defense offers programs for supporting technological innovation (MAFAT, TALPIOT) and many initiatives support dialogue between industry and government. MAFAT is a governmental agency aimed at coordinating between the Ministry of Defense, Israel Military Industries, Israel Aerospace Industries, Rafael Advanced Defense Systems, the Institute for Biological Research and the Space Agency. TALPIOT is an elite Israel Defense Forces (IDF) training program for young people (high school graduates) who have demonstrated outstanding academic ability in the sciences, physics, and mathematics. Graduates of the Talpiot program pursue higher education while serving in the army, and then utilize their expertise in IDF's R&D projects. During their military service, these very young people develop considerable entrepreneurship skills and gain substantial work experience in a highly competitive and high-pressure environment. After the completion of their military service, Talpiot graduates easily assimilate into the Israeli labour market and occupy senior positions in the Israeli high-tech industry[23].

Incubation system

Incubators play an important role in the Israeli innovation ecosystem, the structure of which began in the early 1990s[24]. The program was expected to have complex effects: (1) further expansion of one of the key sectors for economic growth, the R&D and Innovation (R&D) sector; 2) market entry of small businesses through project generation; 3) the reduction of territorial disparities and the catching-up of peripheral areas; 4) productive placement of immigrant, skilled labour and progress in social inclusion; and (5) the absorption of domestic and foreign capital for innovation purposes[25]. A major change in profile took place once in the nearly three decades of the incubator program at the turn of the millennium when ICT and software innovation tenders overtook medical, biotechnology and pharmaceutical research[26]. At

[23] Frenkel, A., Maital, S., Leck, E., Getz, D., & Segal, V. (2011): Israel's Innovation Ecosystem . Izrael: Samuel Neaman Institute.

[24] Grünhut, Z. (2016). Tudatos tudástermelés, Az izraeli innovációs inkubátorok . Tudás Menedzsment, 131-141.

[25] Modena, V., & Shefer, D. (1998): Technological incubators as creators of high-tech firms in Israel. European Regional Science Association (old.: 1). Austria, Vienna: European Congress.

[26] Cohen, E., Gabbay, J., & Schiffman, D. (2010): The Office of the Chief Scientist and the Financing of High-Tech Research & Development. Israel Affairs, 286-306.

the end of 2008, 41% were in medical and related instrument development, 18% in bio and pharmaceutical technology, 12% in software development, 10-10% in communication, environmental and agricultural technology, and 6% Electrical engineering research was carried out in incubators[27]. According to international trends and experience, the most successful incubation procedures are associated with technology-intensive, innovative businesses, start-ups based on specialized knowledge and skills. Israel is one of the most eclectic examples of how serious economic success factors such as incubation mechanisms can become - with appropriate contextual factors and the use of well-thought-out polycyclists. The Jewish state's political, economic, geopolitical, and social ecosystem provides a mix of favourable and unfavourable conditions for this innovative and business-friendly incubation environment. Israel is an excellent model for RDI practices in general, and specifically for incubation mechanisms.

Public agencies

Support for private sector activities for enhancing innovation is given by two public agencies: the Israeli Industry Center for R&D (MATIMOP) and the Israel Export Institute. MATIMOP, the executive agency of the Office of the Chief Scientist of the Ministry of Industry, Trade, and Labour of Israel (OCS), is the official National Agency for industrial R&D cooperation charged with promoting highly supportive policies to build Israel's industrial infrastructure and nurturing industrial innovation and entrepreneurship. This agency generates and implements international cooperative industrial R&D programs between Israeli and foreign enterprises. The Israel Export Institute is an Israeli government agency that operates under the Ministry of Trade and Labour to facilitate trade opportunities, joint ventures, and strategic alliances between international businesses and Israeli companies.

The role of VC-s

There was a growing demand for venture capital funds ready to invest in the early stages of business start-ups since the early 1990s, but these types of funds were scarce. To this end, the Israeli government prepared a program to boost the venture capital industry, launching the Inbal initiative in 1991. The intervention set clear priorities: to provide a 70% state guarantee on investments and to encourage the expansion of the capital market by creating funds. A total of three foundations were institutionalized but did not fulfill their expectations: they collected little private funding; they were unable to mobilize

[27] Pridor, R. (2009): Technological Incubators Program. USA: InfoDev Annual Report Presentation.

critical mass within the innovation system, and did not contribute to network and cluster building; they have proved to be rather bureaucratic, failing to meet market requirements; besides, they have opened up too wide a range of eligible enterprises[28]. The main benefit of the program was, in fact, a list of inferences that could be deduced from which a new, profoundly reformed model, called Yozma, was launched in 1993[29].

Under Yozma, the state earmarked 100 million dollars, 80 for a total of ten equity funds to provide 40-50%, and 20 for direct high-tech investments. An important feature of the program was that it attracted significant private and market capital at an early stage so that only half of the money managed by the ten equity funds to be set up was provided by the state. Also, Yozma guaranteed for five years, at a rate of 5% per annum, an option to redeem the State's share, which was used by investors in all funds, meaning that not only did the program be privatized in the short term, it also generated profitable capital. The Israeli experience shows that without the involvement of market participants (full transfer of private capital, professional control, facilitation of privatization on favourable terms), the public sector is slow, bureaucratic, not sensitive and adaptive, and too rigid and inflexible. Supported start-ups have become dynamic due to easy-to-obtain, passive investments, their growth has been slow, and state supervision and monitoring have not proved to be motivated either. The strongest catalysts of the Israeli innovation eco-system are the joint demand and supply processes, focusing on government and public policy measures, private sector activities, and dual private-public initiatives[30].

Those countries wishing to adopt the Israel model should always be aware that formal organisational, institutional, financial, and so on structures are always based on human agents, with their worldview and identity, and other informal qualities[31].

[28] Avnimelech, et al. (2008): i.m.
[29] Grünhut, Z. (2017): A kockázati tőke szerepe az izraeli innovációban. TERÜLETFEJLESZTÉS ÉS INNOVÁCIÓ, 12-21.
[30] Frenkel (2011): et al.: i.m.
[31] Grünhut (2016): i.m.

1.3.China

Following a long and unprecedented economic development in the last thirty years, China is entering a stormy period for the upcoming new industrial revolution. As China begins to catch up with the world leader in technology, it is approaching an innovation frontier where productivity can no longer be increased by foreign direct investment (FDI) and technology transfers only, thus generating domestic innovation. It is therefore, essential for the economy to move from an investment-driven model to a productivity-based model[32]. High consumer demand and domestic competition in consumer-driven innovation-based industries are likely to compel Chinese companies to compete even harder on the domestic market and expand internationally, leveraging their home-based experience in the global arena, particularly in emerging markets[33].

1.3.1. A historical perspective

Since the start of the Reform and Opening Program launched by the Communist Party in 1978, the country has achieved an average GDP growth rate of almost ten percent per year for the last few years, raising its GDP per capita to more than 50 times the 1978 figure. From $ 155 to $ 7,920 in 2015, lifting 800 million people out of poverty, contributing more than one-third to poverty reduction between 1990 and 2005. By numbers, China is already a world leader in promoting innovation. The country's annual research spending exceeds $ 300 billion, slowly but surely catching up with the United States. Almost 30,000 students graduate in science and technology each year, and the country is the world leader in the number of patent applications filed, with nearly one million filed in 2014[34]. However, the performance of Chinese companies that innovate for business and compete in the global market does not always reflect the potential that would be suggested by the level of investment in the country and the level of R&D support[35]

[32] Eckart, J. (2016. June 23.): 8 things you need to know about China's economy. Forrás: https://www.weforum.org: https://www.weforum.org/agenda/2016/06/8-facts-about-chinas-economy/

[33] Balogh, L. (2017): Lehet-e Kína a következő ipari forradalom nyertese. Hitelintézeti Szemle, 73–100. and Vértesy L. (2011): Financial and legal opportunities on the new Silk Road. in Jogelméleti Szemle 2011/1. szám

[34] Global Patent Filings Rise in 2014 for Fifth Straight Year; China Driving Growth. https://www.wipo.int/pressroom/en/articles/2015/article_0016.html Geneva, December 14, 2015

[35] Balogh (2017): i.m.

As China's share of the global revenue base reveals, China has emerged as a world leader in sectors that have evolved to serve domestic demand, while more challenging innovations such as private label drugs, biotechnology or the automotive industry, China has not yet become globally competitive[36]. The Internet Plus Action Plan, announced by Prime Minister Li Keqiang at the 12th National People's Congress in March 2015, aims to promote further the use of Internet-based technologies in traditional sectors as well as broadband internet access and promote business development in rural areas by improving e-commerce[37]. Like the United States, China is trying to move from manufacturing activities to high value-added services as quickly as possible.

1.3.2. Main elements and players

China's innovation ecosystem is characterized by the strong position of local government and official research institutes. The state council has final decision-making authority for the structural organisation of the research system and guidelines for research policy. Traditionally, there has been a disconnect between academic and industrial research. Today, however, universities are increasingly pursuing exciting joint projects with enterprises. They are also setting up their technology enterprises. Technology parks and incubators connect entrepreneurs with local resources.

China has developed national mid and long-term plans for scientific and technological development that set building an innovative nation as a strategic goal; put in place plans to develop nine strategic emerging industries including next-generation information technologies, high-end equipment, new materials, bio-industry, new energy vehicles, new energy, energy conservation, and environmental protection, digital creativity and relates service industry[38]. In 2015, China launched a pioneering program called Mass Entrepreneurship and Innovation. This is in line with the country's goal to shift from labour-intensive manufacturing to growth driven by innovation. The country also has an enormous and valuable internal consumer base, which is hungry for new technology[39]. In recent years, the government has also launched several

[36] The China Effect On Global Innovation. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Innovation/Gauging%20the%20strength%20of%20Chinese%20innovation/MGI%20China%20Effect_Full%20report_October_2015.ashx, (October, 2015)

[37] Aikman, D. (2016): www3.weforum.org. http://www3.weforum.org/docs/WEF_GAC_On_China_Innovation_WhitePaper_2016.pdf

[38] Rising Innovation in China (2019): China Innovation Ecosystem Development Report 2019. https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/innovation/deloitte-cn-innovation-china-innovation-ecosystem-report-en-191101.pdf. (September, 2019)

[39] Aikman (2016): i.m.

programs aimed at cultivating scientific talent. The more prominent among these include the National Science Fund for Distinguished Young Scholars, which provides research support to deserving scientific projects, the Chang Jiang Scholars Program aimed at attracting distinguished visiting professors, and the Thousand Talents Plan aimed at luring back top Chinese researchers from abroad[40].

Innovative regions

In the rankings of cities in China in terms of innovation ecosystems, the cities are divided into three tiers based on their total scores. Among the first tier, Tier 1 cities, including Beijing, Shanghai, Shenzhen, and Guangzhou, remain at the top, with Hangzhou rising to the fourth place in replace of Guangzhou. Nanjing, Chengdu, and Wuhan are among the top few in the second tier. The third tier mainly includes cities that promote breakthroughs of innovation ecosystems via policy guidance, such as Dongguan, Foshan, Zhuhai, and Guiyang.

On the regional level, innovation ecosystems in China are distinct in characteristics. Innovation development in the Beijing-Tianjin-Hebei region is centered in Beijing; the overall level of development in the Yangtze River Delta region is higher than in other regions; the development in the Guangdong-Hong Kong-Macao Greater Bay Area is promising; the central and western regions are accelerating development[41].

Hi-tech parks

China sees rapid development in more than 130 high-tech parks and independent innovation demonstration zones. These parks and zones, accounting for less than 1% of China's territory, account for nearly 40% of R&D investment by all the country's enterprises, as well as 32.8% of revenue from sales of new products.

The Zhongguancun Science Park (Z-Park) in Beijing recorded 4.07 trillion yuan in revenues in 2015. Covering only 3% of the land, it contributed 37% of Beijing's economic growth. The Z-Park is already at the global forefront in such sectors as Internet+, AI, biomedicine, smart manufacturing, and new materials. Strategic emerging industries contributed 71.6% of its revenues.

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[40] Gupta, A., & Wang, H. (2016. November 16.): https://hbr.org. Harward Business Review: https://hbr.org/2016/11/how-chinas-government-helps-and-hinders-innovation

[41] Rising Innovation in China. China Innovation Ecosystem Development Report 2019. https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/innovation/deloitte-cn-innovation-china-innovation-ecosystem-report-en-191101.pdf. (September, 2019)

Shenzhen has been spending over 4% of its GDP on R&D in recent years. In 2015, its GDP expanded by 8.9%. The value added by its seven strategic emerging industries increased by 16.1%, and GDP grew from 28% five years ago to 40% today. In 2015, Shenzhen also submitted 13,300 PCT patent applications, representing 46.9% of China's total. The city leads the world in such sectors as supercomputing, gene sequencing, metamaterial, and 4G technology. It is home to 1,283 labs, including key labs, engineering labs, engineering centers, and corporate technology centers[42].

Sectoral characteristics

Manufacturing is the fundamental industry for China's innovation development. In China, the advancement of a smart manufacturing ecosystem would not be possible without a deep dive into user values. China has a complete set of supporting industries for manufacturing and, therefore, could help manufacturing enterprises go even further on the journey of a smart upgrade. However, to play a leading economic role, China has to make a similar shift from manufacturing activities to high value-added industries.

The best practice of innovation ecosystems in China is the AI industry. Fueled by both policies and capital, the number of AI enterprises is rising rapidly, with the most located in the Beijing-Tianjin-Hebei region, Pearl River Delta region and Yangtze River Delta region[43].

Intellectual Property

The common thing many foreign founders are scared of is IP leakage. The fundamental difference between China and many other countries is that IP in China does not follow a first to use, but first to file a trademark system. A foreign business can register its trademark, have local authorities raid infringing factories, take infringers to court, and have Chinese customs seize infringing goods before they leave China's borders. Foreign investors must prepare early, register trademarks and other key IPs in China, and understand how to use the system. It is important to get good legal advice regarding IP well before approaching the market[44].

So, China is no longer just the home of copycats. Massive investments, a huge market and the hiring of worldwide talent have boosted the innovative

[42] Aikman (2016): i.m.

[43] Rising Innovation in China. China Innovation Ecosystem Development Report 2019. https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/innovation/deloitte-cn-innovation-china-innovation-ecosystem-report-en-191101.pdf. (September, 2019)

[44] Lu, D. (2017. August 3): https://medium.com. https://medium.com: https://medium.com/textbook-ventures/what-i-learnt-from-the-chinese-innovation-ecosystem-7d4fd48ce951

Chinese ecosystem. Today, some of the biggest companies in the world are based there. China is already moving from a policy-driven economy, with a big share of investment in GDP and its specialization as the "workbench of the world," to a market-driven economy. One where consumption counts for the larger share of GPD with a focus on an innovative, service-driven economy[45].

The role of VC-s

Since the 1980s, venture capital in China has grown steadily alongside the robust national economy. In 1984, the National Research Center of Science and Technology for Development suggested that China establish a venture capital system to promote high technology[46]. The early 1990s saw a proliferation of venture capital firms backed by state and local governments. Because of the lack of experience among the government officials and the entrepreneurs, these efforts usually failed[47]. To increase the professionalism of the industry, the Chinese Venture Capital Association was inaugurated in 2002 and it has experienced extensive growth in the years since[48].

There are hundreds of government guidance funds (on the national, provincial, city, and district levels) that are focused on venture funding in China today. Some of these funds allocate capital to further specific policy plans, such as 'Made in China 2025,' or towards advancing areas such as AI and robotics. Unlike private venture capital, government guidance funds are well represented in inland regions[49]. The leading private VC institutions in China include Zhen Fund, K2VC and Sinovation Ventures in the initial funding stage, and IDG Capital, MatrixPartners, and Sequoia Capital China in the subsequent funding stages. While most of the top venture capital firms invest most heavily in internet services, Tianxing Capital invests in chemistry and new materials as well as on green tech and energy[50].

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[45] How China Creates the Strongest Innovation System. https://bmilab.com/blog/2017/11/29/how-china-creates-the-strongest-innovation-system (December 6, 2017)

[46] White, S., Gao, J., & Zhang, W. (2005). Financing new ventures in China: System antecedents and institutionalization. Research Policy, 894–913.

[47] Oster, S. (2001. July 28). AsiaWeek.com. AsiaWeek.com.

[48] Ahlstrom, D. (2007): Venture Capital in China: Past, Present, and Future. Asia Pacific Journal of Management, 247-268.

[49] Larsson, T. (2019. March 18). https://www.linkedin.com. https://www.linkedin.com: https://www.linkedin.com/pulse/9-things-know-chinas-startup-boom-tomas-larsson/

[50] China's start-up landscape (and how to engage with it). https://press.covestro.com/news.nsf/id/2018-177-EN/$file/KAIROS_ENG.pdf (SHANGHAI 2018)

Foreign investors are a growing presence in China's VC scene. The case for China is strong: outside of the US, China is the clearest investment opportunity for foreign investors in terms of potential scale and growth. With a population of over 1.38 billion people, China is a market where 'popular' takes on an entirely different meaning. For investors, whether in transportation or logistics, fintech or biotech, China's startup scene is exceptional in every way. In support of this, the Foreign Investment Law (FIL), which was passed on March 15, 2019, during the 13th National People's Congress, will likely have a further stimulating effect in fostering a foreign investment-friendly environment[51].

Summary

The innovation ecosystems presented all have unique characteristics, strengths, and areas for improvement. Overall, state involvement was the key factor in all three countries. Universities, research institutes, programs to support young researchers, or venture capital funds can hardly be imagined by supporting market players alone. It is also undeniable that, in the case of both the US and Israel, military developments in the national interest have, in many cases, been the cradle of future innovation frameworks. However, after these initial factors, the state played an essential role in ensuring the commercial exploitation of the research infrastructure. It can be stated that the characteristic feature of the examined countries is that the cooperation of the state, the higher education, and the corporate sphere was able to provide a stable basis for serving the ever-changing economic needs.

[51] Larsson (2019): i.m.

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Zsolt Gilányi

2. On the Economic Sustainability of Market Economies

Ecological economics alerts that even durable zero growth (and *a fortiori* growth) at the present level of resource consumption of our modern market economies is incompatible with a sustainable future because it exhausts the non- or "slowly" renewable resources (including the environment). Therefore, degrowth and zero growth in resource consumption (including the environment) to an ecologically sustainable level is a prerequisite for a sustainable future.

The dominant economic thinking (the whole orthodox economics and the outmost of heterodox economics) maintains that zero growth non-crisis steady state is possible in our market economies: in these models, growth is a matter of individual choice between present and future consumption; growth is a matter of the exogenously given preferences. In other terms, there is no intrinsic property of market economies that implies growth imperative. Accordingly, green movements, for example, may, in principle, remedy the excessive ecological footprint of modern economies.

Some economists warn that the orthodox perception of sustainability is basically false; ecological movements aiming at a sustainable future are necessarily ineffective on global level. The anti-these is that growth imperative is an inherent systemic property of market economies; hence market economies are ecologically unsustainable. That growth is a systemic property of market economies means that growth in market economies is not up to individual but to collective choice. Collective choice is substantially different from individual choice: collective choice creates social rules (institutions), while individual choice does not.[52]

Two social rules (institutions) define a market economy. First, market economies are monetary production economies, i.e. the production (creation of social wealth) is monetized. Second, market economies are free, i.e. they are based on private property and decentralization[53]. Growth imperative follows

[52] As an example, I can decide each morning to take or not to take my car to get to work, but I cannot choose to ride on the left or on the right hand side on the road the same morning if I really want to reach my workplace. Riding on the opposite side is possible only if the parliament (collective choice) of a country decides to change the traffic rules.

[53] Note that this freedom does not exclude slavery!

from the social rule of monetary production economy: no growth and monetary production economy mutually exclude each other.

Surprisingly, empirical data do not help in deciding on the validity of these two diametrically opposed propositions. Though historical data show that capitalism experienced in average outstanding growth relative to other economic systems, (interrupted from time to time by a crisis), also capitalism knew long periods of stagnation. Both camps interpret these facts as the empirical evidence of their truth.[54] As a consequence, the debate on the (economic) sustainability of market economies is relegated from the field of empirics back to the field of theory. At first glance, this procedure seems paradoxical: theories are tested by empirical evidence and not the other way around. In fact, all that happens is that the battlefield of testing is shifted from the direct test of the existence of growth imperative to the test of the hypotheses of the opposed theories on growth imperative.

In summary, the sustainability of our modern market economies seems to hurt into ecological, social (inequalities, migration[55]) and economic (growth imperative, crisis) limits. Recently ecological limits of sustainability gained much attention. However, sustainability seems to depend less on ecological limits rather more on social and economic ones.

In the following, we deal with what we think the core theoretical problem of the economic sustainability of our modern market economies: the growth imperative.

2.1. Locating the theoretical problem of growth

In order to situate the theoretical problem of growth, let us consider a closed economy and start from the banal identity drawn from national accounting, which states that in any period t, gross domestic product $\boldsymbol{Y_t}$ can be split up into consumption $\boldsymbol{C_t}$ plus gross investment $\boldsymbol{I_t}$, where the bold typing refers to aggregates:

$$\boldsymbol{Y_t = C_t + I_t} \qquad (1)$$

[54] Is it the Sun that orbits around the Earth or the other way round?

[55] For example, think of Laurent Obertone's (2018) negative scenario on the effects of migration into France. Obertone, Laurent (2018): Conférence de Laurent Obertone á Orange, 12.10.2018.

If net aggregate investments in period t are strictly positive, gross investments are:

$$I_t > A_t \qquad (2)$$

where A_t is the depreciation in period t in the economy.

As depreciation is the result of past investments, equation (2) holds for all periods if and only if gross investment is increasing. As the lower bound on consumption is zero, strictly positive net investment implies a tendency for gross domestic product to grow. In fact, gross domestic product Y may temporally decrease because a drop-in consumption C may counterbalance the increase of gross investments I, but this drop cannot perpetuate because consumption cannot fall below the lower bound zero.

In the aggregate, investments are always equal to savings; hence investments net of depreciation I^N_t in period t always equal net savings:

$$I^N_t = S^N_t \qquad (3)$$

All put together, if aggregate net saving in period t, S^N_t, is a strictly positive aggregate net investment, I^N_t, is also strictly positive. Hence, aggregate gross investment is increasing, and by force of identity (1), gross domestic product abides the same property. No growth is equivalent with zero aggregate net saving, $S^N_t = 0$; growth means strictly positive aggregate net saving $S^N_t > 0$. Thus, a sufficient condition for growth in nominal or real terms is the existence of strictly positive aggregate net savings in monetary or in real terms regardless of the specific model with or without phony mathematics. The specific models are required to make the link between nominal and real growth.

According to this, any growth models must come in one way or another to the same end: aggregate net savings must be strictly positive. In each model where zero growth is a feasible state, net aggregate savings may be zero.

In order to avoid digressions, let us comply with the custom by considering exclusively proportional steady states (i.e. cyclical paths excluded) of a closed market economy and by supposing that none of the economic agents can run a constant negative budget.[56] These hypotheses make the link between strictly positive net retained earnings of one single economic agent and strictly positive aggregate net savings.

[56] In evidence, the state (government) is able to run constant negative budget. A proportional stationary state is a situation, where all variables change proportionally and which can be maintained ad infimum.

In this perspective, the core of the debate on growth imperative is whether the behavioural rule attributed to the model agents allows for $S^N t,i=0$ for all economic agents *i*, or not. If the behavioural rule allows for zero net savings for each economic agent, the zero value of the aggregated net saving $\boldsymbol{S^N t=0}$ is a state, which may be in accordance with the will of the agents and, as such, is a feasible state that can be maintained *ad infinum*. As a consequence, in zero growth models, it is possible that all the economic agents are able to realize their plans *ad infimum* if there is no growth, while in growth imperative models after a while there is necessarily at least one economic agent, who cannot realize his or her plan (regardless of the concrete plan) if the economy does not grow. Michel Rosier calls the situation where there is at least one economic agent who necessarily cannot realize his or her plan (regardless of the concrete plan) (general) crisis and the opposite case when economic agents have the theoretical possibility to execute their plans normal functioning of the economy. In the omnipresent equilibrium models, there is not just a theoretical possibility to execute all the plans, but these plans are *de facto* realized. Inversely, the failure of an agent to realize her plan does not mean that the economy is in crisis.

Logically, there are two ways to assure strictly positive net retained earnings: either we postulate that some economic agent pursuit the aim of realizing strictly positive net retained earnings; or we make other hypotheses that assure this end. In evidence, zero growth models have the same options with the opposite aim to assure zero net retained earnings. These models implicitly postulate that none of the economic agent pursuits the aim of realizing strictly positive net retained earnings. In concrete terms, these models make hypotheses (generally the profit maximization rule) that imply this postulate.

2.2. Toward growth imperative models: the Rosier-model

Though we cannot speak of a generally accepted common core for growth imperative models and Michel Rosier does not speak of growth imperative, Michel Rosier's model[57] seems to be a good candidate for several reasons. First, Rosier's model departs from the postulate that market economies are

[57] Rosier, Michel (1991): Eléments d'une approche théorique et comptable du phénomène d'endettement. Cahier monnaie et financement. Université Lumière Lyon 2. 20. 176-185. and Rosier, Michel (1992): Des causes et des remèdes aux surendettements nationaux et internationaux. Cahier du G.R.A.T.I.C.E.

monetary production economies.[58] This means that the production process is conceived differently from the orthodox theory. The orthodox theory first gives a description of the real economy without money and only afterward tries to integrate money in a second step[59]; accordingly, money is inessential in the economy and hence in the orthodox production process.[60] For Rosier, the economy is *ab ovo* monetary; economic calculus and payments are in monetary terms; the model framework is based on national accounting with some modifications as it is the case in the stock-flow consistent models where the accounting is condensed into the transactions flow matrix.[61] The most aggregated closed economy model has just two macro-agents: banks that can create money and non-bank agents who are unable to do so. That is, if we say that our economies are in the first instance money economies, then the aggregation cannot hide the money creation process, but it can hide the production process: the banking sector's profits necessarily follow (perhaps with some lags) the non-financial sector's profits. Second, as in Rosier's model, production is not made explicit, the problem of connecting real and nominal variables is avoided at the expense of arguing simply for growth in nominal terms. As such, the theoretical possibility to believe in everlasting nominal growth without growing resource consumption remains open: the zero real growth literature is not discredited with a stroke by this maximally simplified model.

It is important to underline again that Rosier does not aim to show that there is growth imperative in modern market economies. He simply shows that if banks convert their savings rather in financial assets than in real assets – which is the case if we observe their balance sheets: the share of real assets compared to financial assets are negligible in banks' balance sheets – then the overall net claims of banks on non-bank agents (i.e. banks' claims on non-bank agents minus banks' financial liabilities toward non-bank agents) is necessarily increasing. Rosier's behavioural hypothesis means that from

[58] This postulate is attributed to Keynes. Therefore, all the models that depart from this postulate are labelled post-Keynesian. Nevertheless, few such models claim growth imperative.

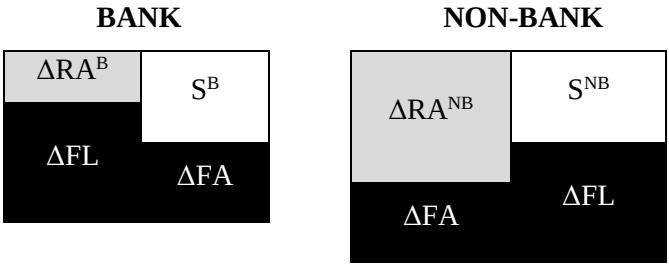
[59] I note that this integration is impossible. For an overview see for example Cartelier, Jean (2018): Money, markets and capital. The case for a monetary analysis, Routledge.

[60] If it were essential, then without money a model necessarily cannot describe an economy with money.

[61] See Godley, Wynne and Lavoie, Marc (2007): Monetary Economics. Palgrave Macmillan. The most important difference between national accounting in practice and this theoretical accounting is that shares are not considered as a part of individual wealth but as an item of financial liabilities for the issuer. This property assures that a society's wealth does not increase with share issuance.

period to period, the increase in banks' real assets is always less than the increase in their financial assets.

The variation of banks' balance sheet during period t fulfills the identity that the variation of all the assets (variation of real assets ΔRA^B, plus the variation of financial assets ΔFL[62]) is equal to the variation of all the liabilities (variation of own wealth called saving S^B, plus a variation of financial liabilities ΔFA):



Formally,

$$\Delta RA^B{}_t+\Delta FL_t=\Delta FA_t+S^B{}_t \qquad (4)$$

According to Rosier's hypothesis, banks real assets always increase less than their positive savings, i.e.:

$$\Delta RA^B{}_t<S^B{}_t \text{ if } S^B{}_t>0 \qquad (5)$$

From identity (4) it then follows:

$$\Delta FL_t>\Delta FA_t \qquad (6)$$

That is:

$$FA_t - FA_{t-1}<FL_t - FL_{t-1} < FL_t \quad \text{as } FL_t\geq 0 \text{ for all t.}$$

Banks' financial assets take all kinds, but basically, they are claims because the bank's main role is to create money by credit in our economies; as a counterpart, banks' financial liabilities are basically money.[63]

This said, if banks have strictly positive savings (i.e. retained earnings) in the aggregate, then there is a tendency for banks' claims in monetary terms (loans of non-bank agents) to increase more than the money stock in the

[62] Because the financial liability of non-bank agents is the financial asset of the bank toward non-bank agents.

[63] Money is financial assets with which one can pay all the claims on herself.

economy. It is important to underline that strictly positive interest rate in itself does not necessarily imply strictly positive retained earnings and hence is not sufficient for growth in monetary terms.

The tendency to increase means that these stocks may temporarily decrease, because banks other financial assets and liabilities may also change, but these stocks cannot decrease durably, because in that case, banks' balance sheets would contradict banks' behavioural rule of creating money *via* credit (and hence banks' balance sheets obtained in the model would contradict the empirically observed balance sheets of the banking sector where loans and money are the dominant entries).

The proposition above can be directly put in an equation without loss of generality if we keep in mind that the simplified equations are to be interpreted as tendencies. Namely, as banks' main role is to create money *via* credit, we omit banks' real asset purchases ($\Delta RA^B=0$). As already noted, this in concordance with the empirical observation that the proportion of real assets relative to the total assets in banks' balance sheets is negligible. Though banks' financial assets take all sorts, they are mainly claims on non-bank agents. We suppose that banks' financial assets are exclusively such claims, which we will call from the point of view of non-bank agents' loan, *L*. Banks' financial liabilities are also of different types, but as a counterpart of loans they are mainly composed of money, *M*. We suppose that banks' financial liabilities are exclusively money, *M*. With these simplifications Rosier's general model can be simplified to:

BANK

$$\Delta M_t=\Delta L_t-S^B_t \qquad (4')$$

Keeping in mind the above simplifications, this equation shows that in a closed credit money economy there is a tendency for the variation of the money stock to be equal with the variation of the outstanding stock of loans on non-bank agents diminished by banks' retained earnings. If banks' savings in the aggregate is strictly positive, i.e. $S^B_t>0$, then (4') becomes:

$$\Delta L_t>\Delta M_t \qquad (6')$$

or

L_{t-1}-M_{t-1}<L_t-M_t≤L_t, as L_t and M_t≥0 for all t.

as above.

In order to illustrate the patterns that the stock of outstanding loans should take in the omnipresent orthodox models with constant money stock, let us consider the following simple example of a credit-money economy. Suppose that all loans taken in period t must be reimbursed with interest in the subsequent period. The interest rate is 10% and there is no bankruptcy. Banks do not spend out of their profits. The money stock is constant, say 100 dollars. In the beginning, there is neither loans nor money. For the money stock to be constant at the beginning (end) of periods, the money inflows must be equal with money outflows during the periods. This means that the amount of money corresponding to the interest payments must also be assured by new loans. Accordingly, the stock of outstanding loans at the end of periods as well as the flow of money and the flow of loans during the periods are increasing:

	Stock		**Flow**	
	The stock of outstanding loans with interest at the beginning of the period, D	Money stock at the beginning of the period, M	Loans taken during the period, FL	Reimbursement with interest during the period, R
0	0	0	100	0
1	110	100	110	110
2	121	100	121	121
3	133,1	100	133,1	133,1
4	146,41	100	146,41	146,41

If banks integrally spend their profits, this growth imperative in monetary terms disappears. This means that compound interest in itself does not lead to growth imperative in monetary terms:

	The stock of outstanding loans with interest at the beginning of the period, D	Money stock at the beginning of the period, M	Loans taken during the period, FL	Reimbursement with interest during the period, R	Expenditure of interest income during the period, O
0	0	0	100	0	0
1	110	100	100	110	10
2	110	100	100	110	10
3	110	100	100	110	10
4	110	100	100	110	10

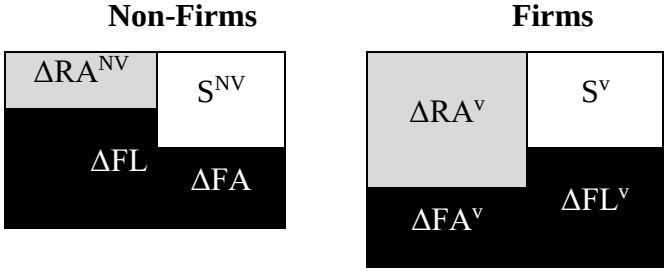
In the first case, trivially we cannot start the subsequent periods with the same amount of money stock at the beginning of the periods because in that case, the ratio of the money stock at the beginning of the periods relative to the flow of transactions during the periods tends to zero, resulting in the impossibility of executing all the transactions. Since, even if on an aggregated level, the initial money stock plus the money inflows cover all matured debts during the periods, these debts cannot be reimbursed if debt maturity inside the period is not appropriate. Image, for example, that at the beginning of period four non-bank agents should reimburse 101 dollars, but they have not taken further loans yet. This means that there are still just 100 dollars in the economy, hence at least 1 dollar due payment cannot be made. It follows that we can suppose that economic transactions take place smoothly during the periods only if the money stock at the beginning of the periods increase more or less proportionally to the flow of transactions during the periods. [64] For this reason, in the first case, the economy is not viable: none of the models (orthodox or not) with constant money stock can describe our modern economies where the money is created *via* credit. For example, if the increase of the money stock is constant 11% in our first example, then both the money stock and the stock of outstanding loans will permanently increase and reach the constant 1:11 ratio in the stationary state.[65]

2.3. Growth imperative in market economies: the Rosier model altered

Let us aggregate economic agents in a closed market economy into two macro agents: firms and all other agents (banks, households, state), called non-firms. The variation of their balance sheets during period t is the following:

[64] The proof of this proposition goes by shifting all the periods in a way where payments are necessarily cannot be executed. This shift means that the beginning (end) of period money stock will become a stock at a moment inside the period that is not represented and a moment previously situated inside the period becomes the beginning (end) moment. The proof also holds if the length of the period is changed leading to a new representation of the reality. The shift or change of periods is possible because model periods are arbitrarily chosen.

[65] This ratio follows from equation (4'). Namely, $qM_{t-1}=qL_{t-1}-rL_{t-1}$, where q is the stationary growth rate, r interest rate. This gives: $M_{t-1}/L_{t-1}=1-r/q$ for all t.



The variation of the balance sheet of firms is:

$$\Delta RA^V_t+\Delta FA^V_t=\Delta FL^V_t+S^V_t \qquad (7)$$

Let us apply now Rosier's argument applied for the banking sector! Namely, empirical observation of firms' balance sheets shows that the share of real assets far exceeds the share of their financial assets. This means that firms place their positive savings rather in real assets than in financial assets. For this reason, we postulate that from period to period the increase in firms' financial assets is always less than the increase in their real assets:

$$\Delta FA^V_t<S^V_t \text{ if } S^V_t>0 \qquad (8)$$

Thus, from equation (7) it follows:

$$\Delta RA^V_t>\Delta FL^V_t \qquad (9)$$

Firms' real asset purchase is investment. Neither real assets nor financial liabilities can take negative values, i.e. $RA^V_t \geq 0$ and $FL^V_t \geq 0$ for all t. It follows that financial assets cannot decrease *ad infimum* either. This means that there is a tendency for $\Delta FL_t \geq 0$. From equation (9):

$$0 \leq \Delta FL^V_t < \Delta RA^V_t = I_t\text{-}A_t < I_t \ (9')$$

This means that in a normally functioning closed market economy, there is a tendency for the net and gross investments to increase in monetary terms.

The income of all economic agents is called the total product, total product minus intermediate consumption measured at market prices is called GDP (Y). $P_t\text{-}CI_t=Y_t=C_t+I_t$. As consumption ($C_t$) has the lower bound *0* and investment is increasing (I_t), there is a tendency for the total product as well as for the GDP in monetary terms to increase. It follows that the money flows and also the money stock must have an increasing tendency.

This means that a normally functioning market economy is compatible only with a financial system where the money stock can increase according to the needs of the economy. In this perspective, the modern monetary system is

just a response to satisfy market economies' thirst for money. Though it is true that the banking system reinforces the need for growth in monetary terms, however, it seems that the banking system is rather an effect than a cause: this is a flexible system that is able to satisfy the money thirst.

If we exclude that firms and commercial banks may fulfil their plans with zero retained earnings, then we do not just have a tendency for growth in monetary terms, but also growth imperative: if the economy (GDP) is not increasing, sooner or later firms (and commercial banks) are unable to realize their plan, because equation (9') will not be satisfied and there will be a crisis.

2.4.Critiques against growth imperative models

Put aside some attempts, growth imperative models argue in an accounting framework, like Rosier. Some economists see in a Rosier type model the demonstration of the growth imperative. In addition to the accounting framework, the Rosier type model highlights the central role of the financial sector, including the assumption that banks retain earnings from strictly positive profits.

In evidence, a Rosier type model is insufficient to demonstrate the existence of growth imperative for two reasons. First, if growth imperative is due to the financial sector, then market economies *per se* are not necessarily subject to the growth imperative. This said market economies' growth imperative must be invariable to the financial system. Second, if banks' profits are not strictly positive but zero – as it is the case in general in equilibrium models – then retained earnings are also zero, and there is neither growth nor need to growth: a Rosier type model always allows for this possibility.

However, critiques do not stop here; they also aim another substantially different assumption on the financial sector not yet made in any models. Namely, instead of the behavioural hypothesis of banks' keeping strictly positive retained earnings from strictly positive profits, the other behavioural hypothesis under attack is that banks seek strictly positive retained earnings. That is, in the first case, zero profit in monetary terms is a situation where banks can realize their plans while in the second case, banks cannot fulfill their plans.

The critiques are twofold. Some claim that the assumption of banks seeking strictly positive retained earnings " *is self-contradictory in an economy designed to converge to a* stationary state".[66] Others call for the "*theoretical foundation*" of his hypothesis.[67]

As to the present state of the art, it seems that there is an implicit consensus among both economists who argue for capitalism's growth imperative and economists who deny the existence of such systemic property that one cannot postulate that for-profit firms and commercial banks seek by definition strictly positive net retained earnings in monetary terms. Otherwise, there were no numerous attempts to assure strictly positive net aggregate savings from other hypotheses. For example, strictly positive net retained earnings is explained by risk considerations[68] or banks' aim to maintain a fairly constant capital to loans ratio[69], or by innovation[70]. All these attempts are of limited success though the model settings vary substantially.

2.5. Refutation of the critiques against the postulate of strictly positive net retained earnings

As to the critique of the lack of the theoretical underpinning of the postulate of strictly positive net retained earnings to assure growth, it also applies to the postulate of the possibility of zero net retained earnings. Namely, if it is assumed that none of the economic agents' aim is to retain net earnings, this should then also be underpinned theoretically as the main reason for zero growth.

The fact that this "critique" also applies to the "opposite" model shows that it is fundamentally misplaced. The problem with this critique is that postulates cannot be "*underpinned theoretically*". Namely, a postulate is, by definition, an assumption that the theoretician makes according to his or her ob-

[66] Cahen-Fourot, Louison and Lavoie, Marc (2016): Ecological monetary economics: a post-Keynesian critique. Ecological Economics. 126. 163-168.
[67] Richters, Oliver and Siemoneit, Andreas (2017): Consistency and stability analysis of models of a monetary growth imperative. Ecological Economics. 136. 114-125.
[68] Gordon and Rosenthal (2003): Capitalism's growth imperative. Cambridge Journal of Economics. 27/1. 25–48.
[69] Binswanger, Mathias (2015): The growth imperative revisited: a rejoinder to Gilányi and Johnson. Journal of Post Keynesian Economics. 37. 648-660.
[70] Richters, Oliver and Siemoneit, Andreas (2017): Fear of Stagnation? A review on growth imperatives. VÖÖ Discussion Papers.

servation of the reality, and that serves for the basis for reasoning in the theory. If two models are logically coherent with different postulates, then the test of the models indicates which model gives a better representation of the reality. In other terms, the test of the model will decide which properties of the reality that the theoretician *a priori* thought important prove to be important *a posteriori*. The argument that in a non-growing economy, some economists see no reason for banks seeking to realize strictly positive net retained earnings in monetary terms is completely irrelevant. With Rosier's terms[71], a hypothesis of a scientific model does not have to be reasonable for the theoretician; i.e. a hypothesis of a scientific model does not have to conform to the understanding of the theoretician.

In order to illustrate the absurdity of the argument behind the rejection of the hypothesis of the behavioural rule of strictly positive net retained earnings, consider the following example. We reject the explication of the phenomenon called "pressure" (macroscopic phenomenon, like growth in economics) on the basis of the kinetic theory of gases (the microscopic theory that makes postulates on gas molecules, as we do in economics on the behaviour of economic agents), because it is not "logical" for me (i.e. it should be "underpinned theoretically") that molecules follow Brownian motion in a closed container (i.e. if I were a gas molecule I would not follow the Brownian motion in a non-changing world like the critics would not retain earnings in zero growth steady state if they were bankers).

As to the critique of presupposing the result, yet again it applies also to zero growth models: if we postulate that none of the economic agent pursuit the aim of realizing strictly positive net retained earnings, then we presuppose the result we are willing to obtain, namely the possibility of zero growth. Hence, we could (erroneously) conclude that zero growth models are inconsistent because they assume that (commercial) banks (and for-profit firms) do not keep accumulating retained earnings in each period, an assumption that is self-contradictory in an economy designed to converge to a strictly positive steady-state growth.

Again, the fact that this "critique" also applies to the opposite model shows that it is fundamentally erroneous. The problem with this critique is that all models necessarily presuppose the model result. With Soros's terms, all model results are necessarily contained in the model assumptions. The problem with a theory starts if it is not supported by empirical evidence: "*In the absence of equilibrium, the contention that free markets lead to the optimum*

[71] Rosier, Michel (1993): L'Etat expérimentateur. PUF.

allocation of resources loses its justification. The supposedly scientific theory that has been used to validate it turns out to be an axiomatic structure whose conclusions are contained in its assumptions ***and are not necessarily supported by the empirical evidence****. The resemblance to Marxism, which also claimed scientific status for its tenets, is too close for comfort.*"[72]

However, empirical evidence in the field of economics is rather precarious, because "*[t]he researcher's free option is in his ability to pick whatever statistics can confirm his belief—or show a good result—and ditch the rest*".[73] According to Romer, "*The trouble with macroeconomics is worse: … In the 1960s and early 1970s, many macroeconomists were cavalier about the identification problem. They did not recognize how difficult it is to make reliable inferences about causality from observations on variables that are part of a simultaneous system. By the late 1970s, macroeconomists understood how serious this issue is, but …we are now "Back to Square One."*[74]

2.6. Some remarks on the standard basic (zero) growth model: the Solow – model

The basic growth model of orthodox economic theory is the Solow model. The Solow model supposes that the production function is first-order homogeneous.[75] Therefore, income is integrally distributed among the "factors of production", namely between capital and labour, where the term capital stands for the means of production.[76]

Hence, in such a model setting, firms have never retained earnings. Only consumers have saving decisions; therefore, investment is the result of the preference between the present and future consumption. In these models, one

[72] Soros György (1997): The Capitalist Threat. Atlantic Monthly. 279/2. 4

[73] Taleb, Nassim (2012): Antifragile: things that gain from disorder. Random House. 431

[74] Romer, Paul (2016): The Trouble With Macroeconomics. https://paulromer.net/trouble-with-macroeconomics-update/WP-Trouble.pdf (2020. 02. 14.)

[75] If all factors of production are increased proportionally, production also increases proportionally. Formally, the production function y=F(K,N), where y is the output, K is capital and N is labor, is homogeneous in first degree if for all a>1, ay=F(aK,aN).

[76] $K_t=K_{t-1}+I_t-A_t$, where I_t is investment in period t, A_t is depreciation in period t. Investment is spending in monetary terms. The translation of a monetary magnitude into real terms is not without difficulties (see 1.7 below). Orthodox models argue in real terms. Accounting approaches argue in monetary terms. Real terms are not directly observable; monetary magnitudes (payments) are directly observable.

can obtain any result (s)he wishes: zero growth or growth depends on the exogenously given preferences.[77]

As firms do not have investment decisions in these models, savings determine investments and not the other way around. For a long time, we all know that in a monetary production economy, the logical chain is in the other way around, as explained, for example by Kalecki[78] or by Keynes (see widow's cruse or paradox of thrift). Hence, by construction orthodox models cannot describe monetary production economies.

Even if left implicit, in orthodox models, firms are supposed to seek profits (maximal or not has no importance for us here). The profit objective is fully compatible with zero net saving. This said, there is no need for growth so that each economic agent be able to fulfill its plan; there is no growth imperative even if we observe growth.

2.7.Growth in monetary terms or in real terms?

As it is clear from the Solow model, orthodox economics thinks in real terms: money, if at all, is added afterward. This procedure is clearly a logical nonsense: the functioning of an economy with money can be understood by examining the functioning of an economy without money only if money is inessential (M. Friedman) or neutral (R. Lucas). However, in that case, there is no need to integrate money into the model. Some non-orthodox economists believe that a monetary production economy (market economy) is different from an economy without money. Therefore, they depart from the existence of money. However, most of the adepts of this heterodox thinking integrate the production function into their models in order to get real magnitudes. They generally make the mistake that in a national accounting (monetary flow) framework, investments also refer primarily to money flows and not to means of production: the passage between nominal and real variables is not underpinned theoretically.

Though the passage between nominal and real variables is generally considered as a simple mechanical calculus, the transformation between these magnitudes is far from being without difficulties, because we should aggregate different products into one magnitude that represent somehow "physical"

[77] This choice is left implicit in the exogenously given savings rates. The aim of internalizing the saving decision by considering the agents' intertemporal choice gave rise to the proliferation of more sophisticated orthodox growth models. The point here is that the net saving rate can be set both to zero or to strictly positive values.

[78] „Capitalist earn what they spend and workers spend what they earn."

quantities. According to the general solution, instead of the genuine money flows, i.e. instead of the GDP measured at the genuine prices, the GDP is calculated with the prices of a fixed period. The first measurement is called GDP measured at current prices or nominal prices, and the latter measurement is called GDP measured at a base price or real price. The reference period is called the base period. If in a period the price of the same commodity bundle is *p* times higher than the price of this same bundle in the base period, then we call *p* price level, *p-1* inflation if it is positive and deflation if it is negative.

From this passage between nominal and real variables, it is clear that different commodity bundle choices will generally result in different price levels. For example, the commodity bundle that represents the total use of products (Y) is probably different from the composition of the consumption goods (C) and of the investment goods (I). Therefore, the price index calculated on the basis of the composition of the commodity bundle that represents the total product will not reflect the evolution of the composition of the GDP in real terms. If the composition changes – and it changes except for the beloved proportional path – then it is not at all sure that the employment or the consumption of non-renewable resources increases if the GDP in real terms increases. For this eventuality, it is enough that the less labour-intensive production increase or the production that does not use non-renewable resources. In brief, the aggregated production functions taken by analogy from the microeconomics textbooks' single firms' production function used in the macroeconomic models are dubious.

In order to illustrate these difficulties, consider one single consumption good and one single investment good, which are different from each other. Hence, there is no problem of measuring the production in physical quantities and the composition of the consumption and investment goods are completely different. Consider the base period 0 and the subsequent period 1 in three different scenarios:

			data		**$P_C C_{real}$**	**+**	**$P_I I_{real}$**	**=**	**GDP_{nom}**		
period	P_C	P_I	C_{fiz}	I_{fiz}	C_{nom}		I_{nom}		GDP_{nom}	P	GDP_{real}
0	2	3	100	30	200		90		290	1	290
1_1	3	2	100	30	300		60		360	1,24	290
1_2	3	2	200	60	600		120		720	1,24	580
1_3	2	3	200	60	400		180		580	1,00	580

	Nominal variables transformed Into real variables			Ratios	
period	C_{real}	I_{real}	GDP_{real}	C_{fiz}/I_{fiz}	C_{real}/I_{real}
0	*200*	*90*	*290*	3,33	2,22
1_1	*241,67*	*48,33*	*290*	3,33	5,00
1_2	*483,33*	*96,67*	*580*	3,33	5,00
1_3	*400,00*	*180,00*	*580*	3,33	2,22

In the base period, real and nominal GDP, as well as the real and nominal consumption and investments by definition, coincide. We can observe that the consumption in real terms (200$\$_0$) does not coincide with the consumption measured in physical terms (100kg), and the ratio of the consumption and investment in real terms (100/45, no unit) is different from the same ratio measured in physical quantities (100/30 kg/liter) because the real variables are influenced by the base period relative prices. For this reason, a proportional growth measured in physical terms (1_2; or the special case of zero growth: 1_1) changes the ratio of consumption and investment in real terms if relative prices change.

This said, the existence of a growth imperative in nominal terms in itself does not necessarily impede the ecological sustainability of an economic system, because nominal growth does not necessarily imply real growth (though this seems to be the general case) and real growth is also possible with structural change (again empirical evidence shows that this change is not sufficient).

2.8.Some concluding remarks

Ecological economics has catalysed pure economic thinking by asking the taboo question about whether modern market economies bear systemic properties required for a sustainable future. Empirical facts seem to show that there is no non-crisis market economy with durable zero growth. However, this empirical observation is not concluding: the fact that we have not seen any durable zero growth non-crisis market economy yet does not mean that we can exclude the possibility to see one in the future.[79]

According to the ruling paradigm, zero growth is possible in a normally functioning modern market economy. Few are those who deny the possibility of non-crisis zero growth capitalism and state that "*Needed: a new economic*

[79] The inconsistency with this quite rational belief in the existence of black swans on behalf of the dominant economic thinking is that this same dominant thinking excludes the possibility of black swans in their models because they use the Gaussian probability distribution. See Taleb (2007)

paradigm"[80]. These economists have spent many efforts to obtain strictly positive aggregate net savings and hence growth from other hypotheses than simply postulating the existence of some economic agents who pursue the aim of realizing strictly positive net retained earnings in monetary terms. None of these models can demonstrate the existence of growth imperative.

If we simply postulate that the aim of production is not to satisfy human needs but to realize strictly positive savings in monetary terms (!), then we obtain growth imperative in monetary terms.[81] Most of the economists call for the theoretical underpinning of the postulate of strictly positive net retained earnings in monetary terms as the reason for a growth imperative. The same "critique" applies to standard economics: the postulate of firms not seeking strictly positive net retained earnings should also be underpinned theoretically as the main reason for the possibility of zero-growth. Also, the objection that the postulate of strictly positive net retained earnings is equivalent to postulating growth imperative; and therefore, these models presuppose the result is also completely irrelevant. In standard economics, the postulate that firms do not seek strictly positive net retained earnings (namely firms seek to maximize profits) is also equivalent with postulating the possibility of zero growth; hence these economists also presuppose what they want to obtain as a result. This said, all model results are necessarily contained in the model assumptions, and none of the postulates can be underpinned theoretically.

None of the models which depart from money[82] is appropriate at present to establish in real terms the growth imperative of market economies *per se*. To do so, an appropriate price theory should be included in these models, which is missing. In brief, a growth imperative in nominal terms is not equivalent to a growth imperative in real terms. As to orthodox models, they cannot describe monetary production economies *per se*, because genuine money is missing in these models, as manifested, for example, in the paradox of thrift.

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[80] Stiglitz (2010): Needed: a new economic paradigm. Financial Times. 08.19.

[81] Two remarks are in due order. First, it is true that a firm cannot sell if its product does not satisfy human needs, but this is just a prerequisite to be able to sell and realize profits. Second, the aim of firms is to realize strictly positive savings and not just strictly positive profits! Think of the difference between for-profit and non-profit firms: non-profit firms also realize profits but they use this profit for other purpose than to realize profits again. This said, a for-profit firm does not always distribute all of its profits as dividend. The omnipresent profit maximization model rule allows for for-profit firms to distribute always all the profits, hence in the orthodox models firms are in fact non-profit firms.

[82] Let us call these models accounting approaches. For example: Kaleckian models, post Keynesian models, stock-flow consistent models, monetary circuit models.

None of the models where the growth imperative is due to the behaviour of the financial sector is appropriate to establish the growth imperative of market economies *per se*. At best, all that these models can do is to establish that the present version of market economies with the present financial system is subject to the growth imperative. These models erroneously suggest that financial reforms would eliminate capitalism's growth imperative.

Orthodox economists believe that all social phenomena, like growth, are the result of individual choice, and therefore green movements may be the cure. Even if it were the case, in order to get zero growth from now on, these economists should explain what would make the same free agents to change their behaviour in a concerted way after some centuries and not to choose available options that lead to growth. Furthermore, why these agents have not chosen the options leading to zero growth in the past? As to the "strength" of this orthodox explication, the same logic applies if we turn upside down the problem. That is, if the observed empirical fact were zero growth capitalism, and we were to expect the black swan of growing capitalism, we should explain why free agents were to change their behaviour from now on.[83]

In brief, for-profit firms' and commercial banks' aim of realizing strictly positive net retained earnings in monetary terms linked to the habitual simplifications of considering proportional steady states and non-negative savings for all economic agents imply that the capitalist system so defined is subject to a double growth imperative in nominal terms stemming from the behaviour of for-profit firms on the one hand and from the behaviour of commercial banks on the other hand. Would a financial reform eliminate commercial banks as proposed in the Chicago plan[84] or just reduce their importance[85], the pace of nominal growth needed for the normal functioning of the economy would decline. This proposition says nothing on real growth – though intuitively, one expects real growth, too.

[83] This logic is frightening: communism and fascism also wanted to change people who not fitted into the system. Should "non-green" people be eliminated?

[84] See for example Benes, J., & Kumhof, M. (2012). IMF working paper: The Chicago plan revisited. WP12/202, August.

[85] See for example Barrdear, John and Kumhof, Michael (2016): The Macroeconomics of Central Bank Issued Digital Currencies (July 18, 2016). Bank of England Working Paper No. 605.

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3. Innovation management; entrepreneurial mindset at large corporates

This section focuses on some important company-level aspects of innovation. First, we will distinguish the basic types of innovation that are present in the life of companies. Then we will describe the theory of disruptive innovation, explaining how innovation can be used to modify business models depending on the relation between the performance of the technologies concerned and customer needs. Afterward, through the collective genius theory, we will explore what kind of organisational cultures encourage innovation. The chapter on entrepreneurship and intrapreneurship will discuss how an organisation can stimulate innovation on both organisational and individual levels. Since innovative ideas may also come from outside the company and be used outside the company, we will discuss the possibilities of open innovation as well.

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3.1. Types of Innovation

Schumpeter, who created the concept of innovation, identified five basic types[86]:

- introduction of new products,
- introduction of new methods of production,
- opening of new markets,
- development of new sources of supply for raw materials or other inputs,
- creation of new market structures in the industry.

Nowadays, we use a modified version of this list proposed by Schumpeter, and we distinguish the following four types[87]:

- product innovation,
- process innovation,
- marketing innovation,

[86] Oslo Manual (2005): 3rd ed. Paris: OECD & Eurostat, p. 29.
[87] Oslo Manual. op. cit. pp. 47–52.

- organisational innovation.

The meaning of the term 'product' must be clarified, as it can be understood in two different ways. When the expression 'product and/or service' is used, the concept of a product does not include services, only physical goods (objects, livestock). According to the other approach, '[m]any people think a product is tangible, but technically a *product* is anything that can be offered to a market to satisfy a want or need, including physical goods, services, experiences, events, persons, places, properties, organisations, information, and ideas.'[88] The latter interpretation includes both physical goods and services in the concept of a product (see, for example, the concept of banking product). We have adopted the second, broader interpretation.

Considering its content, technology can be classified either as product technology or process technology. *Product technology* refers to *what* is created. Product concepts, specifications, designs, application engineering, or after-sales services, for example, are issues of product technology. *Process technology* refers to *how* something is created. Equipment and tooling, the evaluation and selection of the inputs of the production and their suppliers, manufacturing or service systems and technologies, logistics, quality management, and maintenance, for example, are issues of process technology. Consequently, technological innovation also has two types: product innovation and process innovation. This means that the first two items of both lists presented above, i.e. product innovation and process innovation, together make up the concept of *technological innovation*.

In companies manufacturing physical goods, usually, there is a clear distinction between product and process technologies, in services companies, however, that distinction is not always so clear, since service provision, for the most part, is the implementation of a process. Consequently, it is mainly in the case of physical goods that the concepts of product and process innovation can be clearly distinguished, while in the case of services carrying out different processes for the customers, it is far more difficult and sometimes even impossible.

Innovation in companies is characterized by the following features[89]:

- Innovation is associated with *uncertainty*: it is not known what the result of the innovation activities will be (e.g. success of the product,

[88] Kotler, Philip and Keller, Kevin Lane (2016): Marketing management. 15th ed. Harlow, Essex, England: Pearson, p. 389.
[89] Oslo Manual. op. cit. pp. 34–35.

process, marketing or organisational method, and how much time or resources will be needed).
- Innovation involves an *investment* (salaries, costs of fixed and intangible assets, materials and services, etc.) that may yield potential returns in the future.
- Innovation is subject to *spillovers*. The benefits of innovation are rarely appropriated only by the inventing company. Other companies that adopt the original innovation can also benefit from it. Imitation costs can be substantially lower than development costs.
- Innovation involves the *utilization of new knowledge* or a *new use or combination of existing knowledge*. New knowledge may either be generated by the innovating company or acquired externally.
- Innovation aims at improving a company's performance by gaining a *competitive advantage* (or maintaining competitiveness) by increasing sales, by reducing costs, or by improving the company's ability to innovate.

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3.2. Disruptive Innovation

What kind of breakthrough opportunities does technological innovation—which has changed the previous conditions of competition—offer, and how can they be seized? The answer can be found in the theory of disruptive innovation, but in order to understand it, first, we must get acquainted with the concepts of this theory.

3.2.1. The Concepts of the Theory of Disruptive Innovation

The theory of disruptive innovation uses the following concepts[90].

Innovation: The use of old or new technology to meet a new or old need for improving the performance of a product or process. This improvement is valued by potential users, purchasers or influencers. (In this theory, influencers should be understood as the decision-makers inside the company.)

According to this approach, we can talk about innovation when either the technology or the need to be met is new. The new need can be either a new

[90] Paap, Jay and Katz, Ralph (2004): Anticipating disruptive innovation. Research-Technology Management, 48(5), pp. 13–22.

need of existing users or of completely new users. The novelty of the technology or the need to be met must always be considered from the perspective of the organisation concerned: if it is new to the organisation, then it should be regarded as an innovation, regardless of whether there is nothing new in it for others. Taking a look at the different types of innovation discussed in the previous chapter, we can see that the concept of innovation used in the theory of disruptive innovation includes technological and marketing innovation but does not include organisational innovation.

Three possible cases of technological innovation

	Old	New
New	✓	✓
Need	X	✓

- *Productivity:* The extent to which an investment in technological innovation yields a measurable change in the performance of a product or process.
- *Leverage:* The extent to which an improvement in the performance is perceived as having value by users, purchasers or influencers.
- *Leverage minimum:* The point at which the users, purchasers or influencers of a product or process first value the performance improvement.
- *Leverage limit:* The point beyond which the users, purchasers or influencers of a product or process no longer value the performance improvement.
- *Drivers:* The performance characteristics whose leverage is the greatest and thus represents the major consideration by potential users, purchasers or influencers when choosing a product or process.
- *Dominant driver:* The driver whose leverage is the greatest. This is the primary aspect considered by potential users, purchasers or influencers when choosing between different products or processes.

A distinction must be made between incremental and radical innovation, on the one hand, and sustaining and disruptive innovation, on the other. *The comparison of incremental and radical innovation refers to how much the new solution is different from the old one from a technical perspective.* The comparison of sustaining and disruptive innovation, however, does not refer

to innovation itself but to its market impact. *Disruptive innovation disrupts the previous business model*, i.e. what is sold, how it is produced, distributed and promoted, who the purchasers and competitors are. *Sustaining innovation, however, leaves the previous business model as it was,* and enables the company to maintain or improve its competitive position within an unchanged framework. Of course, the distinction between the compared categories is far from being clear, so much so that in some cases, it is arguable to which category an innovation belongs.

Those who coined the term 'disruptive innovation' originally used it in a far narrower sense, meaning only cases where a smaller company with products falling into a lower quality and price category and with fewer resources enters a higher category and becomes a competitor of larger companies there[91]. Nowadays, however, almost everyone uses this term in the broad sense mentioned above. Two decades after the introduction of this concept, a terminological debate developed. Some consider the original, narrower interpretation of the term to be correct and the broader interpretation accepted by the majority to be wrong[92]. In the narrower sense of the term, for example, Uber's mobile technological innovation was not a disruptive innovation, since there was no shift from a lower to a higher category, but in the broader sense, it should be regarded as a disruptive innovation. Their only argument for the narrower interpretation is that it follows the original definition of the term. However, the overwhelming majority thinks that the broader interpretation cannot and should not be changed[93]. In fact, if we now switched to the narrower interpretation, we would be in trouble for two reasons. First, we would not have a term for the broader sense, and second, the overwhelming majority of the relevant literature of the past two decades has been written using the broader interpretation, and it cannot be disregarded. Since we agree with the majority opinion, we will also follow the usage of the majority of the relevant literature, i.e. the broader interpretation.

Technologies created through disruptive innovation are called disruptive technologies. While disruptive innovation may mean either the process or the result of innovation, disruptive technology can only mean its result.

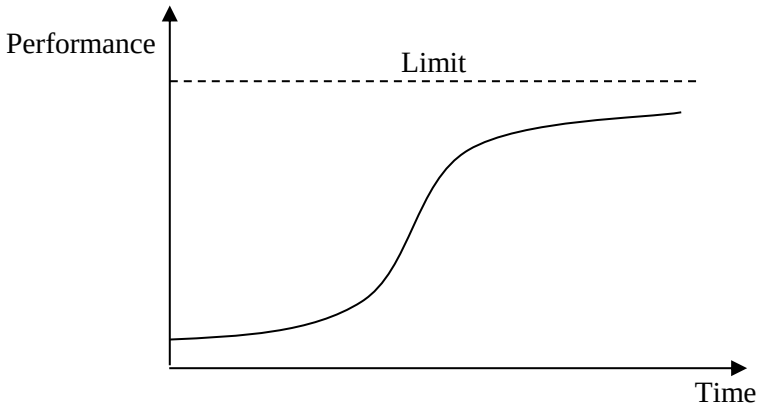
We need two concept pairs instead of one because reality is more complex than stating simply that incremental innovations are sustaining, and radical

[91] Bower, Joseph L. and Christensen, Clayton M. (1995): Disruptive Technologies: Catching the Wave. Harvard Business Review, 73(1), pp. 43–53.
[92] Christensen, C. M., Raynor, M. E., and McDonald, R. (2015): What Is Disruptive Innovation? Harvard Business Review, 93(12), pp. 44–53.
[93] The Disruption Debate (2016): Harvard Business Review, 94(3), pp. 16–17.

innovations are disruptive. The Wankel rotary engine, for example, was a radical innovation, since technically it is completely different from the usual internal combustion engines. Nevertheless, in business terms and taking into account the entire automotive sector, it was not really disruptive, since during its history of several decades it only played a marginal role and proved to be a sustaining innovation. At the same time, the series of incremental innovations of Diesel engines, uninterrupted for decades, has significantly modified the balance of power in the competition within the automotive sector and has finally become disruptive.

The theory that we will now present focuses on disruptive innovation because it is this type of innovation that may turn the balance of power of the competition upside down and offer innovative companies a major breakthrough opportunity. Since this theory compares the performance of the technology concerned with customer needs, we must get acquainted with the S curve describing technological life cycles.

The S curve of technological progress during the life cycle



The S curve shows the evolution of the performance of the technology against time if the development process is continuous. In this theoretical section, we will only represent the time spent on development; therefore, certain authors label the horizontal axis as ‘cumulated development effort’. Should the development process be interrupted for any reason, the curve would continue horizontally and would only start to slope upwards when the suspended development is resumed. For reasons of simplification, we will draw the S curves assuming an uninterrupted development process and disregard any potential interruption; thus, the horizontal axis can be taken as the time axis.

Of course, in real life, development does not follow a continuous curve, it is more like a series of discrete points, each of them representing a new, more advanced version of the given technology. The approximating curve is drawn by us following these points so that we can get a clearer picture of the development.

The limit refers to the fact that the laws of nature limit the possible development of the performance of a given technology. It is impossible to 'raise the limit', since it is immovable, that is why it is a limit. In literature, we usually find the term 'physical limit', while 'limit' without any adjective rarely appears. Here we have chosen to follow the minority usage because the adjective 'physical' applied to the term 'limit' is not the best choice since the limit to the performance increase deriving from the laws of nature may also be a chemical, biological, etc. limit.

3.2.2. The Nature of Disruptive Technology Substitution

After having clarified the basic concepts and the S curve, we can now begin the detailed description of the theory of disruptive innovation[94]. New technologies replace old ones when the following two conditions are fulfilled at the same time:

- there is an unmet need in a (dominant) driver; and
- the current technology is unable to address it.

There are three patterns of substitution where these two forces above lead to pressure for disruptive technology substitution:

1. the performance of the current technology (the S curve) approaches its limit;
2. a new (dominant) driver emerges, but the current technology is incapable of meeting this need;
3. changes in the environment create a new (dominant) driver.

Let us now take a look at the three above possibilities.

1. In this case, the development of the existing technology—i.e. the S curve of its performance—reaches its final stage, where its limit stemming from the laws of nature makes it impossible for it to meet any existing higher need in terms of the (dominant) driver.

[94] Paap, Jay and Katz, Ralph. op. cit.

2. In this case, the needs in terms of the previous (dominant) driver cease to grow, which means that the leverage limit has been reached. Another existing driver becomes dominant, in terms of which the existing technology is unable to meet the increased needs.

An example of this is the 'pixel competition', i.e. the battle between digital cameras in the field of the resolution, which, after some time, became an end in itself and pointless for the overwhelming majority of users. Therefore, the focus of the competition shifted to the improvement of other features: reducing image noise by using a bigger sensor, increasing the zoom with reduced distortion, etc.

There is often significant productivity remaining in the old technology when the leverage limit has already been exceeded; therefore, some manufacturing companies continue to insist on its further development. This is unlikely to provide returns, however, since customers are not interested in that feature any longer and focus on another driver instead. Any company that has a clear idea of the leverage limit and the drivers that are not yet dominant but may become dominant can gain an advantage by realizing targeted developments ahead of their competitors.

3. Changes in the environment of the innovation my generate new drivers. Such changes may include changes in the economic or regulatory environment, the development of new technologies that allow for the creation of new things, changes in the way products are used, the adoption of new technologies by customers, or changes in customers' activities, goals and preferences, etc. The old technology is often able to meet the new needs; thus, no technology substitution occurs. However, if it is unable to meet such needs, the search for a suitable new technology will begin. As opposed to the previous type of innovation, here it is not a previously existing need that becomes a (dominant) driver but a completely new driver comes into existence.

A good example is how mobile photography has spread. Initially, no one ever thought of taking photos with a phone, but when it became possible through an incremental innovation—the combination of a mobile phone and a digital camera (both had already existed, and each of them had been a radical innovation on its own)—, users got to like it, thus a new driver emerged, and the camera built-in mobile phones became a disruptive innovation in the market.

While the first case is evident to all since it is generally known when the performance of existing technology has reached its limit and must be replaced by another technology with a higher limit, in the second and third cases it is not clear at all what the object of development should be.

3.2.3. Anticipating Disruptive Innovation

In all three cases outlined above, the successful management of disruptive innovations requires that the following factors be taken into account[95].

- We have to understand the essence of the dynamics of innovation and the emergence of new technologies: there is an unmet need (old or new), and the technology currently in use (if any) is unable to meet that need.
- When dealing with customers, it is not enough to focus solely on what they ask for now. It is much more important to focus on what they need. We must identify drivers that will emerge among the existing drivers when the currently dominant drivers reach their leverage limit or those that will emerge as new as a result of the changes in the environment.
- We should not replace any old technology just because it has reached its limit of performance. Unless there are significant needs that the existing technology is unable to meet, there is no reason to replace it with another one simply because the latter is new, i.e. 'better'.
- Nevertheless, it is not enough to focus solely on how we can use our existing technologies to address old drivers that are becoming ever stronger. There can be new technologies that not only deliver performance at the leverage limit of the existing drivers (even well below their leverage limit) but also allow for meeting the leverage minimum of new drivers.
- In order to anticipate and manage technological change, we must:
  - collect information on changing needs, technologies, customers, and competitors;
  - take into consideration not only the importance of needs but also their leverage, as well as the limit of the development of technologies and their substitution for new technologies;
  - ensure that when project proposals are approved, priority be given to the early-stage and comprehensive exploration of the possibilities offered by potential new technologies;

[95] Paap, Jay and Katz, Ralph. op. cit.

– adopt development mechanisms that maintain the balance between the operation of our current business model and the innovation aimed at ensuring future competitiveness.

Conclusion of this theory: although we cannot predict the future, we can anticipate certain changes and prepare for them by focusing on the drivers of technology development. In order to ensure early-stage information and rapid reaction, there is always scope and need for even more extensive and comprehensive technology scanning. Any new technology can bring serious changes, for which proper preparation is advisable.

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3.3. Organisational Requirements of Innovation

Previously, the generally accepted position was that true innovators were few since most people were not really creative[96]. Recent research results, however, have revealed that most people are capable of coming up with original ideas if the organisation they work for has a sufficiently non-conformist culture.

3.3.1. Collective Genius

Nowadays, the organisational culture focusing on the 'collective genius' is regarded as the breeding ground for corporate innovation[97]. If people are given opportunities, encouragement and motivation to come up with new ideas, they will produce a surprising amount of good proposals and ideas. It has been found that there are significantly smaller differences between people in terms of creativity and innovativeness than it was previously thought. The reason for which the apparently non-innovative and the silent majority did not come up with new, creative ideas was not their inability to do so, but the fact that the organisational culture and leadership style unfavourable to innovation discouraged them even from giving it a try. In a culture promoting and rewarding originality, however, a surprising number of good ideas emerge and are put to good use. For example, since the Dutch subsidiary of

[96] Hogarth, Robin M. (1987): Judgement and Choice. 2nd ed. New York: Wiley.
[97] Hill, Linda A., Brandeau, Greg, Truelove, Emily and Lineback, Kent (2014): Collective Genius. Harvard Business Review, 92(6), pp. 94–102.

the Tata Steel company group had introduced an organised suggestion programmed, it achieved great results, even saving USD 750,000 in one year alone. A typical employee of the company would make 6-7 suggestions every year and see 3-4 adopted[98].

Innovation usually emerges when diverse people work together to produce a wide range of ideas, which are then refined and developed into even more novel ideas through give-and-take and often heated debates. This means that collaboration must also include passionate opposition. It might be difficult to bear frictions and clashes of ideas since they generate tension and stress. Organisations often disapprove of and try to minimize disagreements, but by doing so, they only stifle the flow of ideas and meaningful discussions needed for innovation. Leaders must manage this tension by creating an atmosphere that is both supportive, so that people be willing to share their talent, and confrontational enough so that they can improve the existing ideas and come up with new ones.

Innovation also requires us to try again and learn from our mistakes and failures. In most organisations, people like to proceed systematically towards the desired outcome: by setting a goal, preparing a plan, assigning responsibilities, working step by step, and monitoring progress until reaching the goal. Innovation, however, cannot be managed in this manner: implementation is not enough; improvisation is also essential.

In order to produce something new and valuable, we must leave the 'either/or' approach behind and move on to the 'both/and' approach. Groups and their leaders often make decisions about the solution of problems through domination or compromise, which leads to less-than-inventive solutions. Innovation requires the integration of ideas into more novel and better solutions, even if, at first sight, they seemed to be mutually exclusive. Leaders must show enough patience to enable the members of all parts of the organisation to produce great ideas.

The community's will and capability to innovate are essential, and it is the duty of the manager responsible for innovation to create this combination of willingness and ability. Both conditions comprise three factors[99].

Willingness

[98] Grant, Adam (2016): How to Build a Culture of Originality. Harvard Business Review, 94(3), pp. 86–94.
[99] Hill, Linda A., Brandeau, Greg, Truelove, Emily and Lineback, Kent. op. cit.

Innovative organisations must maintain a community spirit that relies on the following three elements:

Purpose

In this context, the purpose is not *what* exactly the group is doing but *who* is in it and *why* it exists. A collective identity must be created, and members must focus on a more general, superior and attractive common goal. Purpose makes people willing to take risks and do the hard work inherent in innovation.

For example, a study of the collective identity of Volkswagen employees found that people were proud of VW's role in driving technological and economic progress and they were excited to be part of the effort aimed at building one of the industry's leading brands.

Shared Values

To form a community, group members must agree on what they consider important. Such values influence the group's decision-making priorities as well as individual and collective thought and action. Each community has its own values, however, there are four values that all truly innovative organisations cherish: bold ambition, the responsibility to the community, collaboration, and learning.

Rules of Engagement

Purpose and values, together with the rules of engagement in joint work, keep group members focused on the most important things, encourage activities that foster innovation, and discourage unproductive behaviour. Rules of engagement fall into two categories. The first category contains the rules applicable to the interactions between people: group members are expected to show mutual trust, mutual respect and mutual influence. All members of the community have a voice, and even the least experienced members should be allowed to influence decisions. The second category contains the rules applicable to people's way of thinking: everyone is expected to question everything, be data-driven, and have a holistic view.

Ability

The willingness of the organisation is necessary but not sufficient for successful innovation. Companies also need the ability to innovate. That requires developing three types of innovation capabilities.

Creative Abrasion

The group must be able to generate new ideas through discourse and debate. Instead of obediently following the instructions, the members must debate and argue. Creative abrasion has two essential ingredients: intellectual diversity and intellectual conflict.

Creative Agility

The organisation must be able to test new ideas quickly with multiple experiments. This must be followed by a reflection on and learning from the results of the experiments. Then plans must be adjusted on the basis of the newly acquired knowledge, and new tests and experiments must follow. This cycle must be repeated until a good solution is found or it becomes clear that the basic idea is not going to work.

Creative Resolution

The organisation must be able to make integrative decisions that combine disparate or even opposing ideas.

3.3.2. Creativity and Discipline

According to a frequent misconception, an innovative culture means nothing more than tolerating failure, willingness to experiment, a sense of psychological safety, active collaboration, and non-hierarchical governance. However, this is only half of the truth: all these factors must be counteracted with strict and less entertaining behavioural patterns[100].

Tolerance for Failure but No Tolerance for Incompetence

Since innovation involves the exploration of unknown terrain, it is just obvious that tolerance for failure is an important characteristic of innovative organisations. Nevertheless, they do not tolerate incompetence: they set high-performance standards for their members and recruit the best professionals they can. Experimenting with risky ideas that ultimately fail is fine, but a lack of expertise, negligence, sloppy thinking, bad habits, wrong working methods, and poor management are unacceptable.

Tolerance for failure requires a staff made up of excellent professionals. The development of new technologies or business models is fraught with uncertainty, and ‘failures’ under such circumstances are valuable learning opportunities. However, failures can also derive from poorly thought-out designs,

[100] Pisano, Gary P. (2019): The hard truth about innovative cultures. Harvard Business Review, 97(1), pp. 62–71.

flawed analysis, a lack of transparency or poor management. Google, for example, can encourage risk-taking and tolerate failures because it can be sure that most of its employees are fully competent since each year the company gets over two million applications for five thousand positions.

Maintaining a healthy balance between tolerating failures and eliminating incompetence is not easy. A series of interviews with over 100 employees of Amazon included stories of employees crying at their desks amid enormous performance pressures. One reason that makes striking a balance difficult is that the causes of failure are not always clear.

Willingness to Experiment but Highly Disciplined

Organisations that embrace experimentation are accustomed to uncertainty and ambiguity. They tend to experiment to learn rather than to create a product that is immediately marketable. However, without discipline, almost anything can be labeled as an experiment. Discipline-oriented organisations select experiments with due consideration, on the basis of their potential learning value, and they design them in a way that they can yield as much information as possible compared to the costs. Right at the outset, they establish clear criteria for deciding whether to move forward with, modify, or kill an experiment. They face the facts generated by the experiments in an unbiased manner, i.e. they admit if their initial hypothesis was wrong, and they are willing to kill or significantly modify even those projects that once seemed promising. Being disciplined about killing unsuccessful projects reduces the risk of trying new things. Senior executives must set an example, for instance, by demonstrating a willingness to kill projects they personally initiated or to change their minds on the basis of the data generated by the experiments.

Psychologically Safe but Brutally Candid

In a psychologically safe organisational climate, individuals can speak openly about problems without fear of reprisal. Psychological safety is a two-way street: it is safe for us to criticize the ideas of others, and it is also safe for them to criticize mine – whether they are higher or lower in the organisation. Unvarnished candor is critical to innovation because it fosters the development of new ideas.

In some organisations, confronting one another about different ideas, methods, and results, as well as sharp criticism is all part of the game. Everyone is expected to be able to defend their proposals with data and logic. In other organisations, the climate is overly polite, and words are carefully selected,

criticism is muffled (at least in the open) because to challenge too strongly is to risk looking like one is not a team player.

When it comes to innovation, the candid organisation will always outperform the nice one. The latter confuses politeness and niceness with respect. Frankness is not opposed to respecting, in fact, frank criticism is one of the hallmarks of respect. We can only accept a devastating critique of our own ideas if we respect the contrary opinion of others.

Brutally candid organisations are not necessarily the most comfortable environments in which to work. To outsiders and newcomers, the atmosphere may seem to be aggressive and hard-edged. People do not mince their words. Everything anyone says is scrutinized by the others, regardless of the person's position.

Building a culture of the open debate may be challenging in organisations where people tend to shy away from confrontation or where debate is viewed as violating norms of civility. Senior executives need to set an example by criticizing others' ideas constructively yet without being abrasive. They can encourage this culture of debate by demanding criticism of their own ideas and proposals.

Collaboration but with Individual Accountability

People who work in a collaborative culture find it natural to seek help from colleagues, regardless of whether providing such help is included in their colleagues' formal job descriptions. They have a sense of collective responsibility for their work. Nevertheless, collaboration often gets confused with consensus. An exaggerated focus on reaching consensus can be detrimental to rapid decision-making. Someone has to make a decision and be accountable for it. Committees might prepare decisions, teams might put forward proposals, but at the end of the day, specific individuals have to make critical decisions—deciding about product features, the selection of suppliers, strategies, marketing plans, among others.

Collaboration and personal accountability complement each other. Any decision-maker shutting themselves off from feedback or from collaboration with who could help them would commit an error.

Flat but Strong Leadership

An organisational chart shows the structural flatness of a company but reveals nothing about its cultural flatness. In culturally flat organisations, people are given ample scope for taking actions, making decisions, and voicing

their opinions. Deference is based on competence, not the title. Culturally flat organisations tend to respond more quickly to rapidly changing circumstances because decision-making is decentralized and closer to the sources of relevant information. They typically generate a richer diversity of ideas than hierarchical organisations, because they tap the knowledge, expertise, and perspectives of a larger number of contributors.

A lack of hierarchy, however, does not mean a lack of leadership. Flat organisations require stronger leadership than hierarchical ones. If the leaders fail to set and communicate clear strategic priorities and to give directions, flat organisations slide into chaos. Both Amazon and Google are very flat organisations in which decision-making and accountability are delegated to lower levels and employees at all levels enjoy a high degree of autonomy to pursue their innovative ideas. At the same time, both companies have extremely strong and visionary leaders, who clearly communicate the goals and how their respective organisations should operate.

Flatness does not mean that the management distances itself from operational details or projects. On the contrary, flatness allows leaders to be closer to them. They must be capable of articulating compelling visions and clearly explaining the strategies while simultaneously being competent with technical and operational issues. Steve Jobs was a great example of such a leader: he laid out strong visions for Apple while being passionately focused on technical and design issues. As regards employees, flatness requires them to develop their own leadership capacities, to be comfortable with taking independent actions, and to be accountable for their decisions.

There are three obstacles that make it difficult to build and sustain an innovative culture[101]. First, an innovative culture *requires a combination of apparently contradictory behaviours and, thus, might create confusion.* For example, if a major project fails, it is difficult to decide how to react. Should we hold someone accountable? Should we have made different decisions? What can we learn from this failure? And so on.

Second, *certain behaviours required for an innovative culture can be embraced more easily than others.* Those who view innovation as a free-for-all will see discipline as an unnecessary constraint on their creativity, while those who like the anonymity of consensus will be reluctant to accept personal accountability.

[101] Pisano, Gary P. op. cit.

Third, *innovative cultures are systems of interdependent behaviours, which cannot be implemented in a piecemeal fashion, only together and concurrently.* Behavioural patterns complement and reinforce each other. Highly competent people find it natural to make decisions and to be accountable; thus, their 'failures' are likely to yield learning rather than waste. Disciplined experimentation will cost less and yield more useful information. Accountability makes it easier to become flat, and in flat organisations, information flows faster, which leads to quicker and smarter decision-making.

Leaders must make it clear to their entire organisation that an innovative culture is not all fun and games, but it also entails discipline and responsibility. They must be aware that there are no short cuts in building an innovative culture. Breaking the organisation into smaller units or creating autonomous 'skunk works' can be similar to innovative start-up culture, yet they rarely work. Breaking a bureaucratic organisation into smaller units might be useful, but it does not magically create the required entrepreneurial spirit. That requires a change in values, norms, and behaviours as well. The challenge of building innovative cultures should not be underestimated.

Innovative cultures can be unstable, and when the signs of imbalance appear, intervention is needed to restore balance. This requires leaders to demonstrate, with their own efforts, the ability to strike that balance themselves.

Pál Danyi

3.4. Corporate Entrepreneurship and Intrapreneurship

One of the most crucial challenges for large brand-companies is staying entrepreneurial and innovative. Large companies are typically considered ineffective, not agile enough compared to small innovative companies or start-ups. This issue will be studied here both from corporate and individual perspective: not just the entire company has the responsibility of making organisations more successful in entrepreneurship, but also employees, who can act like entrepreneurs within a company. The latter type of employee is also called *intrapreneur*, and their approach is **intrapreneurship**. A follow-up question naturally derives here: is there any real chance for an employee to become an intrapreneur within a large company? What are the criteria that make a large corporation receptive and supportive enough for intrapreneurship?

This chapter analyses the most important elements of entrepreneurship and intrapreneurship. Although the two concepts are very similar and share the same essence of innovation, they express different approaches. **Corporate entrepreneurship** is about how companies can stimulate employees to show more innovation and initiatives to a company's success[102] **Intrapreneurship** is about the implementation of innovations in organisations, where the adaptation is initiated and wanted by an employee in a bottom-up way[103]. We will focus here more on the intrapreneurial side and explains how the entrepreneurial environment can stimulate intrapreneurship.

According to the serial entrepreneur Kenneth Morse, who is also the founder and managing director of the MIT Entrepreneurship Center, innovation is ***invention*** plus ***commercialization***[104]. (Other sources characterize innovation as innovation + implementation, but we stick with the previous definition.) We also consider two additional aspects, ***corporate culture*** and ***organisation***, that significantly impact the intrapreneurial potential and capability of a company. Summarizing the conceptual framework, we will demonstrate how these four aspects significantly contribute to the success of entrepreneurship and intrapreneurship in a large corporation.

Innovation = Invention + Commercialization

The innovation capability of a company is determined by the invention capability and commercialization capability. In general, a small startup is stronger in the invention, but weaker in commercialization than a larger company. The employees of a small company can view the entire process as a whole, so the inventors will participate in the implementation stage as well, fully understanding the goals and purpose throughout the entire life cycle. In a large company, however, the roles are much more segregated, so employees who make inventions have no clear understanding of how the company may or may not commercialize the conceptualized new product.

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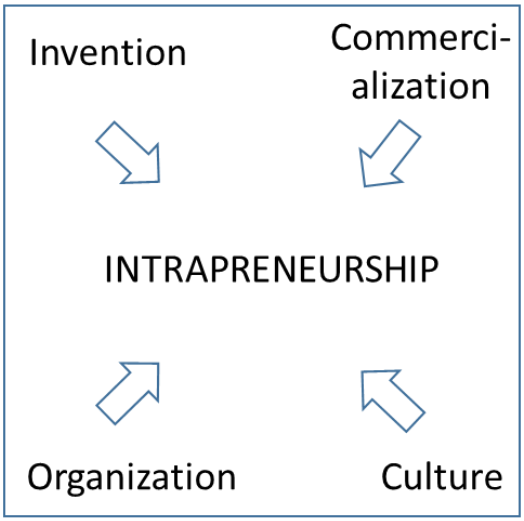
[102] Kanter, R.M. (1984): The Change Masters. Simon & Schuster, NY., and Amo, Bjorn W. (2010): Corporate entrepreneurship and intrapreneurship related to innovation behaviour among employees. International Journal of Entrepreneurial Venturing. 2/2, January 2010. 144-158.

[103] Block, Z. and MacMillan, I.C. (1993): Corporate Venturing. Harvard Business School Press, Boston, and Amo: i.m.

[104] Morse, Kenneth P. (2012): Innovate or Die. Conference presentation. March 22, 2012, https://www.slideshare.net/EsadeCreapolis/ken-morse-innovate-or-die-22-of-march-2012-esadecreapolis-12221356, slide 8 (1/20/20)

The conceptual framework for Corporate Intrapreneurship



A company, which wants to be intrapreneurial, must provide the proper environment. This activity can be supported by many direct and indirect levers, such as organisation, culture, and tools. Based on several decades of experience of the author, the most important activities are listed in the following table. These lists may not be complete but demonstrate the complexity and difficulty of why it is not natural for companies to ensure intrapreneurship.

Best practice levers for intrapreneurship

Organisation	Culture	Specific Tools
Dedicated organisation	Motivation with bonus	Competitions, dedicated events
Clear process of innovation	"Feel the company like yours" campaign	Supporting software
Incubator	Communication of best ideas	Trainings
	Work environment	Agile development
	Free time allocated to new business development	

In the following sections, we explain these activities with examples.

3.4.1. Organisation

Dedicated organisation

When Magyar Telekom (MT) was completely restructured in 2007 as a result of the merger of 5 telecom companies, a new large **innovation business unit** was founded. It was called 'ABCD business unit', standing for Alternative Businesses and Content Development. MT recognized that there was a need for a separate, independent business unit, which could become the company's innovation engine of growth, including the responsibility of most R&D activities.[105] ABCD had the task to recognize the complex services that customers require, and bundle together device (e.g. mobile phones or TV sets), access (internet or cable), and content (video on demand, mobile apps, etc.). The goal was to increase customer spend by entering into new, non-core businesses (e.g., iwiw) that could utilize and leverage MT's existing core assets. It was also an important task to develop attractive content to customers in order to raise the need for core telco services and to boost customer experience. Although this business unit only existed for two years, it developed the concept for new non-core services such as electricity and gas provisioning in the Hungarian market.

Clear process of innovation

Let us investigate invention and commercialization from the process approach. Almost every author in the world of start-ups (Blank, Aulet, Osterwalder, Vecsenyi) has a different model for entrepreneurship, so there is no generally accepted one "silver-bullet" framework. Therefore, we have the freedom to suggest the following five-step model, which is compliant with the steps of the models characterized by the above-mentioned authors.

Invention	1. Ideation (Idea Generation)
	2. Conceptualization and Business Modeling
Commercialization	3. Validation and Market Research
	4. Product Development (Lean, Agile)
	5. Delivery and Utilization

Setting up Innovation Labs and Incubators

Magyar Telekom was one of the first large Hungarian companies which recognized that establishing an innovation lab can serve not just as a CSR activity but also add value to the company's own internal innovation engine.

[105] Magyar Telekom (2009): Magyar Telekom's General Meeting. March 17, 2009. https://www.telekom.hu/static-tr/sw/file/agenda2_IFRS_090317.pdf, https://www.telekom.hu/static-tr/sw/file/agenda1_090317.pdf (1/20/2020)

Kitchen Budapest (KIBU) was founded in 2007, as an auxiliary unit to ABCD. The key concept was becoming independent from the mother company, so making telecom or IT related concepts or products was not a requirement. It also contained a 'maker space' workshop where the tenants could immediately fabricate the working prototype of their ideas. The biggest success of KIBU came right at the start: they incubated Prezi[106] and gave both financial support of 30 million forints[107] and user feedback to them.

K&H "Start It" is another example of how a large brand can support intrapreneurship. After 2015 more and more Hungarian companies established their incubator to get closer to the startup ecosystem and utilize – indirectly – the results of such labs. KBC, one of the leading bank chains in Europe, decided to launch the Start It incubator in Hungary in 2017 after they made huge success with such incubators in Belgium. Their purpose is primarily CSR, to demonstrate their commitment to innovation, new ideas, helping young talents.[108]

KIBU and Start It are examples that do not require for their startups to fit the industry of their mother companies, telecom or banking, respectively. However, there are other examples in the world, e.g., Intel's Venture Capital unit (Intel Capital) which supported primarily such startups that worked in the IT industry: "Intel Capital focuses on making equity investments and acquisitions in support of Intel's strategic interests and invests in hardware, software and services companies in several market segments, including computing, networking, and wireless communications."[109].

3.4.2. Culture

Intrapreneurial culture can boost the innovation performance of a company. As Záboji[110] points out "Culture of an enterprise is determined exclusively by the employees. There is a need for a certain easy-going mentality, so that good mood and laughing should not disappear due to the stress caused by

[106] Magyar Telekom Press (2009): New virtual presentation tool with Magyar Telekom's support. March 26, 2009. https://www.telekom.hu/about_us/press_room/press_releases/2009/march_26 (1/20/2020)
[107] Veiszer, Alinda. (2013): Bridge Generáció. Kossuth Kiadó, 67 (In Hungarian)
[108] K&H Press (2018): Megduplázta kapacitását a Start It @K&H inkubátor. October 19, 2018. https://www.kh.hu/csoport/sajto/-/sajtohir/megduplazta-kapacitasat-a-start-it-k-h-inkubator (1/23/2020) (In Hungarian)
[109] Intel News (2003): Intel Executive Vice President Les Vadasz To Retire. April 17, 2003. https://www.intel.com/pressroom/archive/releases/2003/20030417corp.htm (2/2/2020)
[110] Záboji, B. Peter (2014): Startup, felnőtteknek. Underground Kiadó és Terjesztő Kft., 78 (In Hungarian)

failures. Those companies, which do not provide room for ideas and proposals to change, will not motivate for risk-taking and therefore making errors. These companies will have no chance in the fight for hiring an enlightened workforce of excellent performance."

Company culture is a complex concept, but there are several success criteria that should be followed when companies want to be effective in involving their employees in the internal entrepreneurship process. Some examples are as follows:

Motivation with bonus

An easy-to-implement, typical way to motivate employees is including entrepreneurial activities into the bonus assessment system. If employees had creative ideas that were successfully implemented, special compensation could be provided. At Magyar Telekom, such competitions offered stocks for the winners. Not just employees, but also their managers should be motivated by bonuses; otherwise, managers will not be supportive enough to propagate the innovative initiatives.

As far as the corporate culture of mergers and acquisitions is concerned, international experience says that if you buy a startup, you have to leave them to work with their rules, with their motivation system, and do not try to melt them into the culture of the large corporation. An informal discussion with one of the employees of Ustream confirmed this pattern: one year after the company was acquired by IBM, they still worked in a separate(d) organisational unit, keeping their own, previously developed SME culture.

"Feel the company like yours" campaign

An important strategic exercise is running campaigns that explain the importance of innovation and an entrepreneurial mindset for the employees. One of the best practices is focusing on the engagement and involvement factors of employees. 'The company is yours' feeling is very close to the commitment of start-up owners: they want to make a success of their business.

Communication of best ideas

Communication is an extremely important element of corporate entrepreneurship for all stakeholders. For all employees, the message should include that the company is capable of making a successful business from innovative, new ideas. For the employees who participated in the idea generation or the entrepreneurial process, communication must be acknowledging. Also, the communication must be motivating for all employees emphasizing that "you

can do it", i.e. everybody has the opportunity to create new, fantastic products or businesses.

Work environment

It started late 1990s during the dotcom boom when new startups realized in Silicon Valley that highly skilled, excellent techies prefer a relaxed work environment. So, if they wanted to attract them, the special atmosphere had to be provided for the employees, including amenities such as foosball tables, video games, free soda and lunch, no ties, flexible working hours, happy hours on Fridays, or even gym passes. This was the pattern and the reason for how the Hungarian startup-star Prezi furnished its office in Budapest: to attract the best young IT professionals and make the offices loveable at the same time. The premise was transformed from an old telephone switching center and the designers did a fantastic job.[111]

Free time allocated to new business development

Google's innovation machine is revolutionary. They simply built innovation into their organisational design. Technical employees are required to spend 20% of their time on the technical projects of their own choosing. One employee remembers that when he started his career at Google, he complained to a friend about a Gmail bug: "He told me to fix it myself, pointing me to a document on how to bring up the Gmail development environment on my workstation. The next day my code was reviewed by Gmail engineers, and then I submitted it. A week later, my change was live."[112]

3.4.3. Specific Tools

Idea generation events and systems

One of the best practices of large companies is organising competitions for collecting ideas on new business initiatives. Magyar Telekom, after the 2007 restructuring, had regular internal idea generation campaigns to collect the innovative ideas of employees. ABCD business unit assessed these ideas and provided prizes to the best ideas. The implementation of these ideas is another topic.

Unfortunately, by the author's personal experience, companies fail to develop new businesses from collected ideas because they do not have well-

[111] Michal (2016): Inside Prezi's New Budapest Office. https://www.officelovin.com/2016/08/05/inside-prezis-new-budapest-office/ (1/22/2020)

[112] Iyer, B., Davenport, T.H. (2008): Reverse Engineering Google's Innovation Machine. Harvard Business Review, April 2008

defined processes for such initiatives: e.g., they do not involve the idea contributor into the development stage, they do not make a proper market research before going into production. Another typical problem is when employees suggest new ideas to their bosses, their line managers, who are not motivated enough to understand and evaluate the idea properly; it is much easier for the managers to simply forget about the ideas than spending time on their conceptualization.

Google has introduced a special idea management system: "employees can e-mail ideas for new products, processes, and company improvements to a companywide suggestion box. Every employee can then comment on and rate the ideas."[113] With this feedback process, the company can predict if a new idea will be successful or not among the users: the thousands of review comments can nicely simulate the behaviour of the larger market.

Supporting software

Be-novative.com is a start-up company specializing in idea generation and assessment. Their customers are mainly large companies that want to generate new business ideas by involving their employees in this entrepreneurial step. Be-novative is a platform that "lets you run inspiring ideation sessions and connects diverse groups of people to solve challenges on a global scale. It fuses gamification, crowdsourcing and design thinking, delivering breakthrough solutions."[114] Probably the most useful feature of this platform is able to establish a virtual space online where ideas can stimulate the ideas of others. The feedbacks are aggregated real-time and mapped on a two-dimensional dashboard with free-to-choose axes such as feasibility and impact or novelty and marketability.

Trainings

Companies rarely organise trainings on fostering entrepreneurship. However, trainings on entrepreneurial mindset and performance can significantly contribute to the innovative performance of an organisation. If employees understand the purpose and importance of intrapreneurship, and understand the tools and assets they can utilize, then the huge potential of employee creativity and commitment can be liberated.

Agile development

Agile software development and project management have been with us for almost two decades. They are compulsory methods of delivering innovation.

[113] Iyer, Davenport: i.m.

[114] Be-novative.com (2020): Home page, https://www.be-novative.com/ (2/3/2020)

We only want to emphasize here the most important three features that are fundamental to entrepreneurship: *iterative*; *incremental*; and *full teams*. Iteration makes a product or process development fast and agile when reacting to new demands or requirements. Fast feedback loops, review circles can ensure that development is on the right track. Incremental means that developments can be segmented into functional units that are being built upon each other. Full teams mean that every role and skill must participate in the development process, which are related, e.g. not just developers (coders), but strategists, architecture experts, marketing and sales process analyst, legal experts, and thus, problem-solving should be holistic.

3.4.4. Case study – the intrapreneurial mindset

77 Elektronika Ltd., with more than 700 employees, is one of the few Hungarian brands that could continuously enhance their entrepreneurial agility and performance when becoming a large high-tech corporation from a startup. Established in 1986 as a family business, the company reached its first peak in 2000 when they received the Hungarian Innovation Grand Prize for their blood glucose meter product family. The next worldwide success came after releasing their UriSed product in 2007, which is cuvette-based automated microscopy equipment with particle recognition for examining urine sediment. They could repeat their excellent innovation achievement again in 2016 when the company received the Innovation Grand Prize second time for their semi-automated urine sediment analyser (UriSed mini).

We argue that the biggest contributor to their success is the intrapreneurial mindset of the company and the culture that makes entrepreneurship possible in the entire organisation. To understand in detail how 77 Elektronika could achieve such performance, we discussed the success criteria with Gabor Bayer, Director of Development. This section summarizes the most relevant statements of the semi-structured interview taken on 14 November 2019.

Gabor Bayer joined to head 77 Elektronika's Development in 2004 when the department had 30 employees. Now, in 2019, they have 100 employees.

How are processes different now than 15 years ago?

- Lost some of their flexibility, agility – as Mr Bayer said: „This is the price of growth: you have to give up flexibility e.g. by development of dedicated OEM products for big players in the world market. Now the operation is more stable, and we have much higher revenue".
- Time to Market: in general, time got longer, more control steps, go/no go decisions, much stricter international regulatory requirements.

- Availability of tools: To check the feasibility of certain solutions, experimentation is a must using different tools. Now the company can afford expensive tools that are used rarely, but they want them immediately when needed. (Earlier they could not afford.)
- 10-15% of activities are not planned in advance (e.g., working with new ideas).
- In development: documentation of more details, milestone steps, all the changes are required for large partners (design control).

What is the product planning process before deciding about product development and production?

1. Idea generation
2. Conceptualization
3. Feasibility check parallel with market research
4. Go/No go decision about starting the product development based on the results of the feasibility and that of the market research

How does idea generation work?

- Brainstorming is a constant element of development in all stages.
- Ideas come either internally or from outside: demands from sales partners who know what features or solutions their customers would like to have.

How do you motivate employees?

- Bonus system: employees are rewarded differently, based on their performance.
- Employees can make mistakes (we are human…). Mistakes are escalated only if they have a real impact.
- It is important that employees should not be overstressed – otherwise their performance will decrease.
- Owner aspect: employees look at the company as it had theirs.
- Positive atmosphere: "there is no stupid idea", honest and open discussions.
- Sharing knowledge – it is a required mentality for everybody at Development.

How has the organisation changed throughout the years?

- All departments have been established and further developed that is typical in a large company. It is a full-scale company incl. develop-

ment, separated test group, application team, technology group, procurement/logistics, production, warehouse, quality, IT, sales & marketing, accounting departments, etc..
- Majority of development is execution and not just planning
- Application Team – very important. They communicate what and how the equipment measures. They are responsible for publications, articles, presentations, trainings and application support not only for partners but also for the internal service and marketing departments.
- Quality Assurance – FDA compliance was achieved, responsible for up-to-date SOPs (Standard Operational Procedures).

The Story of UriSed Mini

1. 2013 March- Idea:
   - Market need: How to make the expensive, automated UriSed more affordable for smaller doctors' offices and smaller laboratories?
   - The challenge: "How to make it cheaper? E.g., can we do it smaller?"
   - "Let us do it smaller, that small" → "Ok, then forget automatic sample loading, i.e. the whole robot unit" meaning that the sample entry (the action of filling the sample in the cuvette) should be manual. After that, by pressing a button, everything is the same automatic analysis like in the large UriSed.

2. 2013 April – Internal presentation about the new concept for the CEO:
   - This is a semi-automatic machine for a new market segment, a new instrument category.
   - Interesting direction: „downgrading": the automatic machine was successful, but expensive, mainly for large partners (buyers).
   - 2013 May – Decision, after hesitation, based on feelings. CEO decided: "Let's GO".

3. 2014 H1 – Market Research:
   - Distributors were asked: "Maybe 200-300 equipment can be sold annually".
   - Not necessarily the end-user market should be asked, but the distributors.
   - 2013 Nov: Prototype was demonstrated at the MEDICA Exhibition. Partners hemmed and hawed.
   - 2014 Jan: A US veterinary partner (also in the urine sediment business) expressed interest. They wanted to use it for animals.

- 2014 June: Contract about common development with the veterinary partner.

4. 2014-16: product development including preparation of production
   - New production line
   - 84 new jobs

5. 2016 April – Product launch,
   - 4,9 billion HUF revenue already in the very first year (only 8 months)
   - 2000-3000 equipment sold annually
   - Innovation Grand Prize.

We consider that 77 Elektronika's case is one of the few success stories in Hungary that demonstrates that even a mid-size business (in worldwide comparison) can develop and sell products for the entire world if the product is high quality and innovative. This company started as a traditional small company as an *ant* type business, then with investing in development transformed into a *gazelle* type organisation and reached the *tiger* status when the company became a real innovative intrapreneurial business[115] (Vecsenyi 1999). In addition, this success can be repeated only if the organisation has an entrepreneurial culture and atmosphere.

[115] Vecsenyi, Janos (1999): Vállalkozási szervezetek és stratégiák. Budapest, Aula kiadó. (In Hungarian)

Béla Pataki

3.5.Open innovation

3.5.1. The Concept of Open Innovation

Great ideas can sprout anywhere, they can be easily gathered using modern information and communication technologies, and valuable opportunities for putting them to good use can also arise anywhere. The number of potential partners and ways to collaborate with them is constantly increasing. The awareness of such opportunities has led to the ever more frequent use of the term 'open innovation', and other terms with a similar meaning have also been coined: user innovation, consumer innovation, crowdsourcing, living lab, etc.

'Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.'[116]

Initially, product innovation was the main area in which open innovation was used, particularly in its 'outside-in' form, i.e. using new ideas and knowledge generated by outsiders for developing new products. However, significantly more attention should be paid both to the application of open innovation in process innovation[117] and to 'inside out' innovation, i.e. selling to other innovations that were created but cannot be used inside the company[118].

There are several ways to open up the innovation process to allow outsiders, either innovative experts or consumers, to participate in it. The different forms of opening have different advantages and disadvantages, and they should be used in different situations. The selection of the optimal form is

[116] Chesbrough, Henry William (2006): Open innovation: a new paradigm for understanding industrial innovation. in: Open Innovation: researching a new paradigm. (ed. Chesbrough, Henry William, Vanhaverbeke, Wim and West, Joel) Oxford, UK: Oxford University Press, pp. 1–13.
[117] Krogh, Georg von, Netland, Torbjørn and Wörter, Martin (2018): Winning with open process innovation. MIT Sloan Management Review, 59(2), pp. 53–56.
[118] Chesbrough, Henry William (2012): Open innovation. Insight: Ideas for Change. https://www.youtube.com/watch?v=02tCs3oKovc (Accessed 19/11/2019)

facilitated by a model—the product of approximately twenty years of research and consulting in this area—, which focuses on two basic questions[119]:

- How open or closed should a company's network of collaborators be?
- How flat or hierarchical should the governance of the collaboration be?

3.5.2. Open or Closed Network?

A closed network is created when we invite contributions to the solution of a problem from experts of domains that we consider relevant. An open network is made up of a large number of people who voluntarily get involved in solving a problem that we have made public—participation is open to anyone who wants to join in. Closed modes tend to be smaller than open ones, therefore they are easier and cheaper to operate.

Closed Network

Advantage

We can obtain ideas and solutions from the best experts of the selected knowledge domain.

Issues to be Resolved

Those opting for a closed mode must be able to identify the relevant domains from which the best answers will come and pick the best collaborators in the selected fields.

Conditions of Use

- Capacity to spot previously undiscovered talents within the relevant networks;
- capacity to establish privileged relationships with the best participants.

Open Network

Advantage

A large number of contributors can provide a wide range of interesting ideas or solutions, even from domains that we are not familiar with. It is not necessary to identify either the most relevant knowledge domains or the most appropriate experts in those domains. Indeed, the fact that we do not know

[119] Pisano, Gary P. and Verganti, Roberto (2009): Which Kind of Collaboration Is Right for You? Harvard Business Review, 86(12), pp. 78–86.

them can be particularly valuable; innovative solutions may come from people or organisations we might never have imagined had something to contribute.

Issues to be Resolved

It must be possible to attract and screen a vast number of different ideas from a wide range of domains and contributors.

Conditions of Use

- Capacity to test and screen great quantities of proposed solutions at a low cost;
- IT platforms that facilitate contribution by the participants;
- posting of smaller problems that can be solved using simple tools, or partitioning of bigger problems into smaller chunks that can be handled separately so that contributors can work on them autonomously.

3.5.3. Flat or Hierarchical Governance?

In hierarchical forms of governance, a specific organisation has the right to define the problem and select the final solution. In flatforms, these decisions are either decentralized or made jointly by some or all collaborators.

Hierarchical Governance

Advantage

Our company controls the direction of the innovation efforts and decides who the beneficiaries of the value generated by the innovation will be.

Issues to Be Resolved

Choosing the right direction.

Conditions of Use

- Capacity to understand users' needs and define the problem;
- capacity to create and operate a network in which work can be shared among outsiders and then partial solutions can be integrated;
- capacity to evaluate the proposed solutions.

Flat Governance

Advantage

The burdens (costs, risks, and technical challenges) of innovation are shared. This form works well even when no single organisation has the necessary breadth of perspective or capabilities. (Potential) contributors willingly join this form and collaborate if they see that they can assert their interests and influence decisions.

Issues to be Resolved

Contributors must be persuaded to cooperate and elaborate together with the solution that will be useful for the problem's owner.

Conditions of Use

- Processes and rules that motivate the parties to coordinate work for achieving the common goals.

3.5.4. Four Ways to Collaborate in Open Innovation

The four possible forms of collaboration within the context of open innovation are based on the two network types and two governance types described above.

The four basic models of collaboration in open innovation

		Governance	
		Hierarchical	Flat
Participation	open	Innovation mall	Innovation community
	closed	Elite circle	Consortium

Pisano, Gary P. and Verganti, Roberto (2009): Which Kind of Collaboration Is Right for You?', Harvard Business Review, 86(12), pp. 78-86.

Elite circle

It is a select group of collaborators, in which the participants are selected, the problem is defined and the most appropriate solution is chosen by a single company. An example of elite circles is the group of more than 200 carefully

selected experts invited by Alessi to propose new designs for the production of home products.

It should be used when:

- we know the domains from which the best solution to our problem is likely to come;
- it is important to work with the best experts and we are able to find and select them;
- we can define the problem and evaluate the proposed solutions.

Consortium

It is a private 'club' of contributors, whose members define the problems requiring a solution, make decisions about the workflow and select the best solutions together. For example, IBM has established such a partnership with other companies for developing semiconductor technologies.

It should be used when:

- the problem is big and cannot be partitioned into smaller chunks that can be handled separately;
- we know the domains from which the best solution to our problem is likely to come;
- it is important to work with the best experts and we are able to find and select them;
- all contributors are expected to be highly competent;
- the participants are only willing to collaborate if we share the power with them;
- the intellectual property produced can be shared with the rest of the collaborators.

Innovation mall

It is a forum where a company posts its problem, and anyone can contribute proposals for a solution, and in the end, the company will select the best solution. An example of innovation malls is the InnoCentive.com website, where companies can post scientific problems.

It should be used when:

- contributions are required from a large number of collaborators, and the best ideas might come from unexpected sources;
- a lack of better solutions that elite players not involved in the process could provide does not have serious consequences;

- it is easy to join the network and get involved in the work;
- the problem is small, or if it is big, it can be partitioned into smaller chunks that can be handled separately;
- many proposed solutions can be tried at a low cost.

Innovation community

It is a network in which anyone can post problems, propose solutions and decide which solution to use. An example of innovation communities could be the Linux open-source community.

It should be used when:

- contributions are required from a large number of collaborators, and the best ideas might come from unexpected sources;
- we do not know all user needs; therefore, we want to share the costs and risks of innovation with others;
- it is easy to join the network and get involved in the work;
- the problem is small, or if it is big, it can be partitioned into smaller chunks that can be handled separately;
- it is not important that our company be the owner of the intellectual property, i.e. the solution.

Each approach can be effective under the right circumstances. One must always be wary about opinions stating that one form of collaboration is superior to others. Open is not always better than closed, just as the flat is not always better than hierarchical. The development of an effective approach to collaboration begins with a solid understanding of the company's strategy. What is the business problem that the collaboration is expected to solve? What unique capabilities can we bring to the process of innovation?

Designing financial and non-financial incentives that attract collaborators is crucial in any of the four forms of collaboration. Non-financial rewards—like high visibility in the labour market, good reputation among a peer group, the psychological fulfillment of pursuing a professional interest, or the chance to use the solutions in one's own business—can replace or complement monetary rewards. There are no rigid rules about which incentives work best with particular forms of collaboration.

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Kelemen Ottó János

4. The role of the state, the entrepreneurial state

We have previously learned about the role of the state, and after superficially repeating these, we highlight four topics that give us a better understanding of what it is actually doing. However, before we do, let us look at what tasks the state has. We highlighted four main topics that will make it clear from the practical side what the state is doing. These include research and development, environmental protection and a complex safety net that is being used during an unexpected economic recession. Nevertheless, these are the following: legal, institutional framework, stabilisation, redistribution, allocation.[120]

Providing the legal, institutional framework for economic activity:

In order for the economy and the market to function, it is necessary to create the laws and authorities that define and enforce the rules applicable to all players. The protection of private property, the freedom of enterprise, the protection of consumers, competition and taxation all require legislation that must be enforced.

Role of stabilisation:

The self-regulatory role of the market does not always lead to economic equilibrium. Unemployment, inflation, economic downturn, and deficit may accompany operations. These need to be counterbalanced and managed, which is also implemented by the economic policy of the state. In the event of market destabilization, the state also strives for full employment. It also aims to create a welfare triad. You have many tools to do this in your arsenal.

Redistribution role:

With the help of the tax system, it withdraws income from economic agents and transfers transfers (unpaid income) from it to other actors. The level of income withdrawal is adjusted to the ability to generate income. Higher-income players contribute to a greater extent, while lower-income actors contribute less or no contribution to public spending. This is not always the case.

[120] Vértesy László (2014): Az állami beavatkozás joga és hatékonysága. Nemzeti Közszolgálati Egyetem. 31-38.

Let us just look at what and how the iPhone came about. (See State vs. iPhone)

Allocation responsibilities:

It encompasses all public activities which affect the quantity, composition and quality of the goods and services produced in the economy. Within this framework, the state produces or produces public goods, manages externalities, restricts monopolies, supports road construction, public transport, and agricultural prices. The allocation role allows you to use tax money to finance investments that make the environment greener; or even tax the polluters with a higher tax.

If we are to pursue an innovation-driven, sustainable and inclusive economic environment that respects social and environmental constraints, the status of the state must be restored, both in our minds and in our actual income accounts. Enterprising means not only managing a business but also characterized by the taking of financial risks in the hope of profit[121].

4.1.Creating Markets, not only fixing them

Exploring and understanding of externalities is also important in your studies. It is an important factor that we consider in the political or economic decision-making process (or more precisely in the preparation of the decision-making process).

Externalities when the well-being (profit-costs or utility level) of an economic operator (producer or consumer) is directly influenced by the activities of another economic operator, i.e. not through the price system. We are talking about effects that are not caused by the price system, that is, by the functioning of the market mechanism[122].

How the decisions of economic agents are able to influence the decisions of other players by mediating equilibrium prices. For example, if a new producer enters the market for a product, the profits of the other producers will change as well, and this will not leave consumers' welfare intact. Although the activities of the new entrant have an impact on the profitability of other producers and on consumer welfare, we do not call this effect an externality,

[121] Mazzucato Mariana (2019): Value of Everything: Making and Taking in the Global Economy. Great Britain, Penguin Books

[122] Hal R. Varian (1992): Microeconomic Analysis. New York, Norton International

since the effect of this is on the price system through the operation of the market mechanism[123].

For the same reason, it is not considered an external effect if, for example, an increase in income due to a tax cut affects the welfare of other economic operators through changes in equilibrium prices. The study of externalities is particularly important because, in our microeconomic studies so far, we have found that the market mechanism coordinates the activities of economic operators through the price system, leading to Pareto-efficient states. This may not be true for external effects.

Note that if the ownership rights for external action are clear and if the parties have the opportunity to negotiate with each other, a situation is created as if there is a market for the underlying rights (mutually beneficial win-win situation). If the parties can begin to bargain free of charge for changing the original situation, all that is done is to create a hitherto lacking market for the free sale of the rights in question. As soon as the sale and purchase of these rights are completely free and there are no other obstacles to the transactions, the resulting situation will be effective markets[124].

The state and government have prominent and non-transferable roles in two important areas: one is to protect the present society and health and environment; the other is to shape the future generation through education and environmental protection. The rest (development of infrastructure, support of agriculture, assistance to private enterprises, etc.) follow. So, research development has always been overshadowed in our history. Just think of the two R&D drivers: aerospace and military[125]. Let us ask: What do we spend more on Public Health insurance or space research?

If no one can be excluded from consuming an animal, and if the animal can be used by an unlimited number of consumers without shortening each other in any way. In other words, if consumers of a given commodity do not rival each other, then the commodity in question, distinguished from commodities to which the above criteria do not apply, is called a public good.

The opposite of public goods is private goods. So far, our microeconomic studies have focused exclusively on private goods. Private goods are products and services that are subject to foreclosure (for example, those who do

[123] Michael E. Porter (1998): On Competition. New York, Free Press.
[124] Coase Ronald (1974): The Lighthouse in Economics. Journal of Law and Economics. 357-376.
[125] Veres Lajos (2017): Appreciation of the State Role in the Economy. Polgári Szemle. 116–132.

not pay for them cannot participate in the consumption of the good) and consumers rival each other. The consumption of one consumer reduces the consumption of the other.

Since the exclusion criteria and the lack of rivalry criteria jointly define the public good, there are obviously temporary cases where only one of the two criteria is met. Goods, where both the impossibility of exclusion and the lack of rivalry exist at the same time, are called pure public goods. Transitional cases bear certain features of public and private goods. It may be possible to exclude some of the consumption of a given commodity, but consumers of the commodity do not shorten each other. But it may also be possible to exclude an animal from the consumption of an animal, but the more people have access to the animal, the less valuable it is to them. To distinguish these cases from pure public goods, they are called mixed goods or unclean public goods.

In the Middle Ages, tolls were levied on users of roads and bridges; later in most places, the state made the use of roads free of charge; and since the end of the twentieth century, more and more places have been paying for the use of roads. Public service television broadcasting is accessible to everyone, but at low cost, broadcasting can be coded and some can be excluded from consumption. Some commercial taxes also make use of this possibility[126].

Providing such leadership, the State makes things happen that otherwise would not have. Not only does it stimulate the economy through interest rate policy and redistribute collected taxes, but it also finances basic research, maintains research institutes, finances education, and maintains universities, or healthcare. Through these added values, the state only profits indirectly through taxes. But is it justifiable that the state acts for the public interest and is a courageous actor in the economic system? The characteristics of public good and the role of externalities lead to an understanding of the possibilities of the State. There is not only a narrow view of what the State can invest in or what (in the economical role) policy options are acceptable[127].

Anyone who takes the risk gets a profit in modern capitalism. To understand the fundamental role of the State in the pioneer innovation sector, we have to recognize the collectivizing power of the state.

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[126] Porter Michael (2000): Locations, Clusters, and Company Strategy, New York, Oxford University Press.

[127] Milton Friedman(1979): Crowding Out or Crowding In? The Economic Consequences. NBER Working Paper.

Private investors often follow a predetermined path. Thus, in the hope of growth in business, they do not have to go through many walked paths or dead ends. The need to deploy and to prove new technologies appears both the supply slice, but also on the demand side. The question arises as to what recognition the state will receive for the work it is invested in: especially from the most pressing social and technological challenges.[128]

4.2.State vs. iPhone

From the internet to nanotechnology, most of the technological breakthroughs of the past half-century have been funded by public organisations, from basic research to commercialization of exploitation[129].

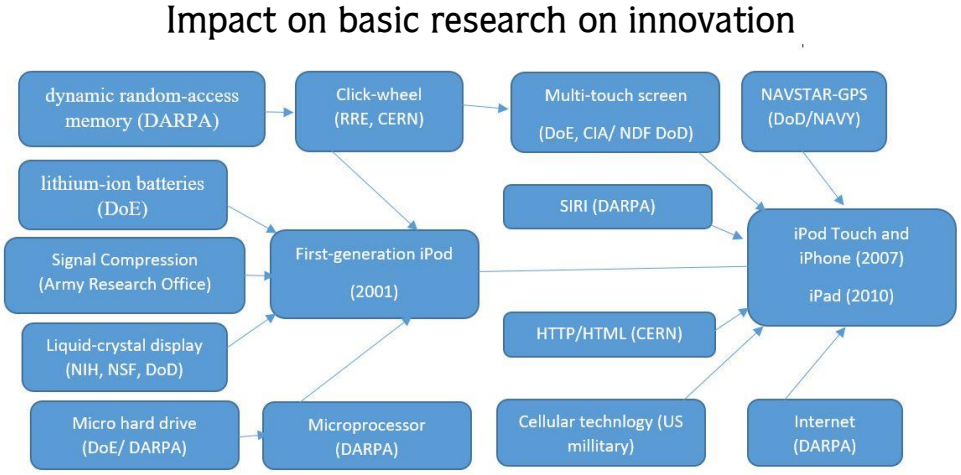
The hero of many, Steve Jobs, has combined many of the existing solutions that were developed earlier by the State of the USA. The basic research was funded by the US (evidently from taxes) and Apple distributed it to consumers. This working method is true from the first Macintosh PC. There are 12 major technologies integrated within the iPod, iPhone and iPad that stand out as features that are either enablers or that differentiate these products from their rivals in the market. These improvements are the result of successful chin-driven units. Is that rather value creation or value extraction? The fair distribution of profit may be questionable, but only one actor received the honor. „These include semiconductor devices such as:

- microprocessors or central processing units (CPU);
- dynamic random-access memory (DRAM); as well as
- micro hard drive storage or hard drive disks (HDD);
- liquid-crystal displays (LCDs);
- lithium-polymer (Li-pol) and lithium-ion (Li-ion) batteries;
- digital signal processing (DSP), based on the advancement in fast Fourier transform (FFT) algorithms;
- the Internet;
- the Hypertext Transfer Protocol (HTTP) and Hypertext Markup Language (HTML);
- and cellular technology and networks – all of which can be considered as the core enabler technologies for products such as the iPod, iPhone and iPad. On the other hand,

[128] Mazzucato Mariana (2018): The Entrepreneurial State: Debunking Public vs. Private Sector Myths. Great Britain, Penguin Random House, 168.

- global positioning systems (GPS),
- click-wheel navigation and multi-touch screens,
- and artificial intelligence with a voice-user interface program" [130]; [131].

Innovative features that have drastically impacted consumer expectations and user experiences, furthermore enhancing the popularity and success of these products. The following diagram takes a closer look at the core technologies and features that Apple has managed to ingeniously integrate, initially in the iPod and later on the iPhone and iPad. These state-developed solutions have changed the world for all of us.



Mazzucato Mariana (2018): Entrepreneurial State: debunking public vs. private sector myths: The State Behind The iPhone. Great Britain, Penguin Random House UK, 116.

However, the state only indirectly benefits from these successes in the form of taxes. At the same time, countless ongoing research leads to a dead end, with its risks and losses alone. The public sector, on the other hand, only adapts and communicates successful solutions [132].

[130] Nintil (2015): The Entrepreneurial State: The case of the iPhone (II). https://nintil.com/mazzucato-and-the-iphone-ii-the-myth-of-the-entrepreneurial-state/ (2019.10.06.)
[131] Mazzucato Mariana (2018): Entrepreneurial State : debunking public vs. private sector myths: The State Behind The iPhone. Great Britain, Penguin Random House UK 81-125.
[132] Mazzucato i.m.

Basic research is the beginning of a process and a prerequisite for innovation. Innovations are not only new products and technological production processes but refer to many more and wider phenomena, including new organisational forms and the creation of new markets. Most of the innovation literature defines innovation as something that is new to the firm adopting or developing it, rather than new to the whole market or indeed the whole world.

Basic research starts a lot, which does not seem like the result right away. Basic research is followed by applied research, which is conducted according to a directed goal. Innovation development is specifically designed to meet latent needs and, if successful, production development will tailor the product to the client's needs. Here the client means the company. At the time of the sale, Deürl was light that it was worth investing in this work. What is outlined in this paragraph is how much preliminary work is needed to put together a new innovative product. All elements of the following Ishikawa diagram were born under similar prerequisites.

Recognize that the state not only spends money but also invests and takes risks, while at the same time receiving the return on its investments only indirectly through increased tax revenues due to the enrichment of the private sector. Finally, if, in a particular case, it is concluded that public good can best be realized in the financing of the State, it does not follow that the execution itself must be carried out by the State. In such cases, it is advisable to entrust the work to private companies, which are more cost-effective than state-owned companies, through appropriate competitive tendering. But only one possible answer is to trust the state. This would be a viable option if the state had adequate information on consumer preferences and income status. In practice, the government does not have the information needed to produce the public good at the optimum level. Decisions are usually made under conditions of uncertainty, so the more general criterion for optimal decision is to maximize the difference between expected benefits and expected costs.

The time Factor: Uncertainty and risk mean that the consequences of the alternatives available can be multiple and occur with different probabilities.

4.3.State vs. Climate changes

At the last climate conference in Paris in December 2015, the participating states undertook to balance emissions by 2050 with the ability of nature to absorb greenhouse gases in order to keep global average temperatures (measured by the Industrial Revolution up to 2100) below 2 °C. That is, emissions

are reduced to levels that can be absorbed by natural processes, which is essentially a carbon-neutral global economy. To achieve this goal, advanced economies will provide $ 100 billion in aid to developing countries. The achievement of the objectives set shall be reviewed every five years. These resources are implemented by the EU through the Member States.

It is also worth noting that it is a binding EU target for a 40% reduction in greenhouse gas emissions by 2030 compared to 1990 levels. The share of renewable energy should be raised to at least 27% by 2030 27% improvement in energy efficiency compared to projections completing the internal energy market by achieving the 10% minimum interconnection target for existing electricity networks.

Furthermore, in line with the European Council agreement of October 2014, the EU has committed itself to reduce greenhouse gases within the Union, increasing the share of renewable energy sources and improving energy efficiency. The implementation of this framework requires an urgent adaptation of the legislation. This is where the role and responsibility of the legislator appears. This is not a purely economic decision but an ethical one. Although nowadays, Technology allows us to produce cleaner energy in a more cost-effective way.[133]

If the State making an investment in the Internet or clean energy (because of the national security or for achieving energy independence, or political reason), it can do so on a scale and with tools not available to businesses: taxation, regulation, monopolization, market manipulation, etc. Environmental public procurement is often referred to as green public procurement. Green public procurement is a procedure whereby public authorities give priority to the purchase of goods, services and works which are less harmful to the environment than other goods for the same purpose. Green public procurement encourages the development of environmentally friendly technologies and products and supports their widespread market penetration.

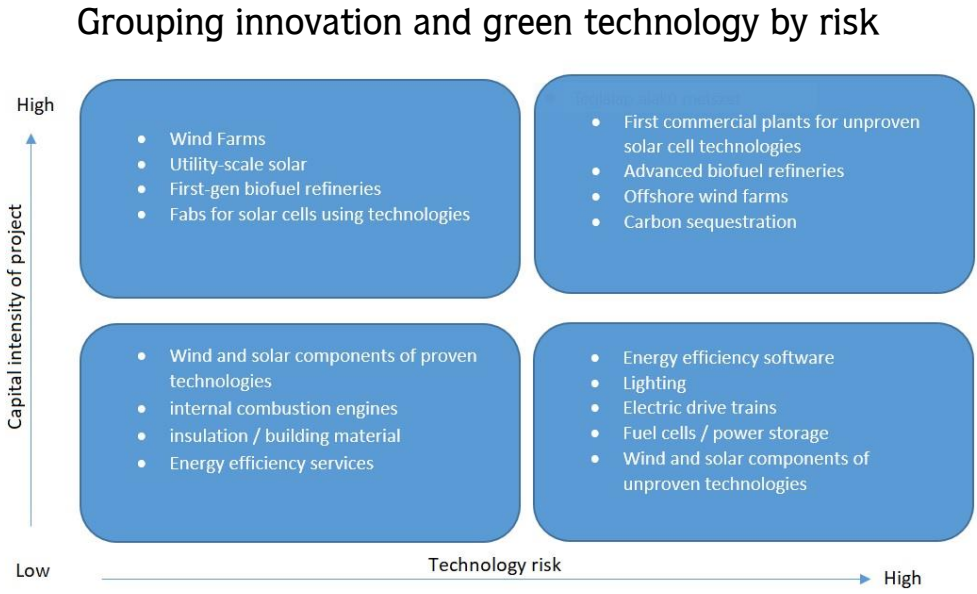
If a central hurdle to business investment in new technology is that it will not make investments that can create benefits for the 'public good' (since it then cannot capture the majority of the value created), then it is essential the State do so – and worry about how to transform those investments into new economic growth later.[134]

[133] Council of the European Union 2019

[134] Ghosh Shikhar and Nanda Ramana (2010): Venture Capital Investment in the Clean Energy Sector. Harvard Business School Working Paper, 11-20.

A series of agreements between states can lead to green investments (green loans, green bonds, green investments). The state can control the market by supporting investments and varying degrees of taxation, or even create markets! Moreover, able to shaping existing frameworks by supporting research and development, incubator programs, competitions, or even withdrawing grant money (from e.g. polluting companies). Climate change affects us all. Individually we can do less for it than collectively, so the state has a role in managing the markets, not only fixing them [135].

As you can see the capital requirement for given technology investment and its risk increase in a straight line. As a result, small garage companies have no chance of being a breakthrough. Excluding costly funding for basic research is a reasonable market opportunity. At the same time, the value of innovation is not for the skillful sales guy, but for the company / state who takes the risk. This shows that small start-ups can play a minimal role in green investments and technological developments.



Mazzucato Mariana (2015): The Entrepreneural State: Debunking Public vs. Private Sector Myths. Great Britain, Penguin Random House UK, 137.

[135] Perez Carlota (2003): Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages. United States, Edward Elgar Publisher.

4.4.Fixing Markets - financial crisis ’08

The state must intervene forcefully in a crisis to bring order and balance. For example, in an extreme case where one of the state's goals is to provide liquidity and maintain creditworthiness in the financial sector during a crisis. States, for example, one of the objectives of the State is to provide liquidity and maintaining creditworthiness in the financial sector. States have used different methods to help banks, including capitalization, with or without nationalization.[136] Guarantee for interbank deposits or loans, and taking over the wrong tools[137].

An excellent example of capitalization through nationalization is the case of the British Northern Rock Loan. In 2008, the British Parliament passed the Banking (Special Measures) Act, which gave the state 100 percent ownership in Northern Rock. The reason for the nationalization was the protection of the public interest, but it was clear that there was a perception in the background that the collapse of the bank could cause untold damage to the UK banking system as a whole. Thus, capitalization with or without nationalization: guarantee for interbank deposits or loans, and wrong tools[138].

An excellent example of capitalization through nationalization is the case of the British Northern Rock. The British Parliament passed the Banking (Special Measures) Act of 2008, which gave the state 100 percent ownership in Northern Rock. The reason for nationalization was the protection of the public interest, but it was clear that there was a perception in the background that the collapse of the bank could cause immense damage to the entire banking system in the United Kingdom.[139] Before considering the idea of nationalization in an advanced democracy, let us remember the 1907 Bankers' Panic and its secondary effects and its externalities.

The banking system, or indeed the entire financial market system, can find a way to make money from mere speculation. (this is called Value extraction and not financing the production economy)

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[136] Vértesy László (2020): Jog és pénzügyek a bankszektorban – általános rész. Akadémiai Kiadó, 2020. 80.

[137] Mazzucato, Mariana (2018) :Innovative Enterprise and the Theory of the Firm: In Rethinking Capitalism. New Jersey, Blackwell Publishing, 180.

[138] Tomasic Roman (2008): The rescue of Northern Rock: Nationalization in the sharow of insolvency, Corporate Rescue and Insolvency: http://ssrn.com/abstract=1422571 (2020.02.05)

[139] UK legistation: Banking Act (special provisions) (2008): http://www.statutelaw.gov.uk/content.aspx activeTextDocId=3450001 (2020.02.05)

So, the money is self-financing: think of the banks that finance mortgage-backed securities, which in turn are covered by credit derivatives. It would not finance 'capital development' in the economy. There is nothing wrong with this, as financial intermediaries 'just' drive demand away from supply. If a business is born voluntarily, it creates value for both parties. The speculative and short-term nature of the financial system means that the banker today is much more of a problem than a solution, contrary to what Schumpeter assumed

Initially, only the tensions in the US mortgage market started to accrue later in other leading capital and money markets in the world. Then, in the US, more and more unsold or foreclosure properties became available, and bankruptcies of smaller banks and credit institutions increased. And in September 2008 came the great shock, the collapse of the Lehman Brothers, and with it the crisis. The bankruptcy of Lehman Bankruptcy triggered panic sales on American stock exchanges and marked the beginning of a lasting global economic recession.

The consequences of the deepening financial crisis have worsened in both the US and Europe, and a little later in the Far East. A 'good decade' has passed since the burst of these dramatic events. It is important to consider whether the dangers of a decade ago may reappear, or whether we can reassure ourselves that a shock of this type and magnitude is no longer a threat.

Can we trust that the new safety systems, special brakes and modern forecasting mechanisms that have come into play on the international financial markets now allow us to see the danger ahead and act in time? Difficult questions, which unfortunately are clearly and reassuringly answered in all respects, cannot be offered by politics or investors, especially the narrower profession of finance.

The state budget is not similar to the household budget, so the emphasis on fiscal austerity is mistaken. But what is a good solution[140]? This question will be answered by the next generation of financial experts.

The most important conclusion is that while both the cyclical conditions and the financial systems have stabilized in the most advanced countries of the

[140] Randall Wray and Yeva Nerssyan (2015): Modern Money Theory. 86.

world economy, it cannot be said with certainty that all risks previously leading to recession could have been adequately addressed[141].

At the beginning of this century, the subprime mortgage crisis almost covered the developed side of the world with the darkness of the Great Depression in 1929-33. The mispriced real estate what bought from cheap (typically floating rate) loans, and the asset price bubble causes falling growth and then explosion-like falls. As everything in the world strives for balance. The dynamics of Newtonian physics can also sometimes model economic processes. Even today, there are growing signs of the next crisis, we know it will happen, but we do not know when[142].

In any case, the crisis will have (at least) two big group of losers:

- Those who invested real estate from floating-rate loans in the hope of increasing the house price; they are the yield hunters or rent-seekers.
- And those who have no savings.

There will be an intersection of the two sets, who will not be helped by the capitalist market. "It is therefore recommended to think of crises as the Buddhists do about death: it is not certain when and how they will occur. But it sure will happen."

Let's look at the tools the state balances worldwide. This is one of the true roles of the state: the very visible hand. Here are the Government-funded subsidies (as a first-aid), which (with taxpayers' money) have rebalanced the capitalist world. And these are only a few tools for the coordination of efficient markets:

- capital injection
- asset finance
- credit guarantee
- rate cuts
- wider hedging need
- narrower discount gap
- federal exchange
- suspension of transactions at market price
- dividend suspension

[141] Bernanke Ben (2017): Volt merszünk cselekedni - Emlékirat egy válságról és utóéletéről. Budapest, Napvilág Kiadó.
[142] Magas István (2019): Tíz évvel a világgazdasági válság után Egy retrospektív elemzés. Pénzügyi szemle, 94-110.

- setting payment limits

Sustainable and balanced growing; and ethical economics is away from the money manager capitalism or casino capitalism behaviour. The excessive growth of fund managers and investment funds, in which case the financial sector is gaining more from serving and speculating on other financial firms than the goals of the real economy, and does not bring any significant added value [143]. Therefore, following the Anglo-Saxon tradition, you should: fix the roof when the sun is shining.

For example, only a few years ago, as a result of the 2008 crisis, the Bank of England acknowledged that it is not deposits that create loans, but, conversely, that loans issued by banks trigger deposits [144].

The financialization of the real economy, that is, the phenomenon of ultimately distorting the concept of value often results in industrial and service companies generating higher revenues and profits from financial operations than from their core business [145].

Sharply criticizes Milton Friedman's principle that the only task of companies is to maximize shareholder value - it favours short-term thinking over the long-term, supports speculation, discourages productive investment, and ignores the fact that not only owners are considered to be a relevant group for the company, but also employees, business partners, the host community, civil society, i.e., all stakeholders. According to Friedman, shareholders are kűey players because they bear the risks of the business and are therefore entitled to profit [146].

In addition to banks, the large "innovators" and "startups" known today in the innovation industry also, in most cases, also show annuities as profits. The basic problem is that the mainstream approach does not take into account that innovation is a collective and cumulative process.

In the current system, the risks are borne by the community and the profits are shared by some of the distinguished players in the private sector. The

[143] Minsky, Hyman (1992): The Financial Instability Hypothesis. The Jerome Levy Economics Institute of Bard College Working Paper

[144] Kolozsi Pál Péter (2018): Itt az ideje másként nézni az államra! – Értékteremtés és innováció a 21. században. Hitelintézeti Szemle, Budapest, 140-150.

[145] Mazzucato Mariana (2019): Value of Everything : Making and Taking in the Global Economy. Great Britain, Penguin Books)

[146] Milton, Friedman (1979): Crowding Out or Crowding In? The Economic Consequences of Financing Government Deficits, Harvard University NBER Working Paper no. 284.

theory of innovation in Silicone valley garages is clearly wrong and misleading. They have decades of meticulous scientific work behind them, financed by someone else. The situation is complicated by the fact that these basic researches are typically carried out by public institutions and not by private companies, as the high capital requirements and risks involved are not borne by the private sector. [147]

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[147] Lunt Neil (2017): The entrepreneurial state: service exports in healthcare and criminal justice. York, Journal of International and Comparative Social Policy.

- Mariana Mazzucato. „Pushing vs. Noodling the Green Industrial Revolution.” In *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*, szerző: Mariana Mazzucato, 168. Great Britain: Penguin Random House UK, 2018.
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Szőcs Árpád

5. Market-based financing of innovation, a detailed introduction of primarily market-based methods of financing

In recent years the digital economy has given rise to many new forms of financing and has added new roles to classic forms of financing. Compering to the traditional innovation supporting banking services,[148] new and alternative funding resources have become globally available to all innovative startups through online platforms. The privilege of being an investor has suddenly become accessible to the average person and is no longer just a playground for wealthy individuals and institutions. In the following, we will look at new funding frameworks born in the digital world and try to predict their future development: crowdfunding, business angels, venture capital.

5.1. Crowdfunding

The increasing penetration of the Internet and digital devices allows new solutions to emerge in traditional sectors such as financing. Crowdfunding has recently emerged as a principal force in entrepreneurial finance, fostering economic empowerment and a democratic transformation of the financial sector[149][150]. Given the difficulties in fundraising via the established ways, mainly due to strict lending requirements and limited access to bank loans, entrepreneurs opt for alternative sources to fund their ventures. Serving as a "bridge" for entrepreneurs and funds, crowdfunding enables fund-seekers to overcome those limitations by making use of the Web 2.0 applications. Those applications facilitate inexpensive mass appeals to a global crowd, allowing fund seekers to reach millions of potential investors, with no costly intermediaries such as banks or underwriters[151]. In this new form of financing, individual preferences of investors may also appear, by investing in topics and products that they are familiar with.

[148] Vértesy László (2020): Jog és pénzügyek a bankszektorban – általános rész. Akadémiai Kiadó, 2020. 88-89.

[149] Assenova, V., Best, J., Cagney, M., Ellenoff, D., Karas, K., Moon, J., Sorenson, O. (2016): The present and future of crowdfunding. California Management Review, 125-135.

[150] Block, Colombo, Cumming, & Vismara, 2018

[151] Agrawal, A., Catalini, C., & Goldfarb, A. (2015): Crowdfunding: Geography, social networks, and the timing of investment decisions. Journal of Economics & Management Strategy, 253–274.

It is important to note, however, that the digital world tends to underestimate the background knowledge required by some professions. Financial institutions and venture capital fund managers are typically experts who have learned over the years; for example, what aspects of a business are worth financing. In light of that, despite its advantages, crowdfunding comes with significant risks to the investor. The most significant risks are lending risks and counterparty risks, which can be partly mitigated by the platform[152]. Besides, the typically small amount of investment allows more and more people to try themselves as investors and to obtain financing companies that would not or would be harder to do with traditional tools.

5.1.1. A historical perspective

While some people claim that crowdfunding can be traced back to the 1700s, others cite a campaign by Joseph Pulitzer as the first crowdfunding campaign. When the U.S. found itself unable to raise enough money to pay for a base for the Statue of Liberty in 1885, Pulitzer used his newspaper, The New York World, to raise money to cover the cost from more than 160,000 donors in just five months. Crowdfunding as we know it today kickstarted in 1997 when fans donated $60k online to the British rock band Marillion to fund the band's reunion tour[153]. Michael Sullivan is credited with coining the term crowdfunding back in 2006 with the launch of fundavlog, a failed attempt at creating an incubator for videoblog-related projects and events, including a simple funding functionality. But the term crowdfunding only really began to be used by the masses a few years later with the advent of the platform Kickstarter[154].

Subsequently, the process began, resulting in rapidly growing crowdfunding platforms. It is important to mention Indiegogo created in 2008, and Kickstarter established in 2009. Today, Kickstarter is almost the same concept for testing new creative ideas and products as Google is for getting information. Since its launch, 17 million people have backed a project, $4.7 billion has been pledged, and 176,425 projects have been successfully funded[155]. Assisted by the widespread adoption and social acceptance of Web 2.0 technologies, crowdfunding expanded on a large scale, providing the infrastructure

[152] Bethlendi, A., & Végh, R. (2014): Could it Become a Viable Option for Hungarian Small Businesses? Financial and Economic Review, 100-124.

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[154] Castrataro, D. (2011. december 12.12.2011): www.socialmediaweel.org. Forrás: https://socialmediaweek.org/blog/2011/12/a-social-history-of-crowdfunding/

[155] (https://www.kickstarter.com/, 2020.01.23.)

to reach millions of investors and supporters online[156] [157]. Employing platform mediated approaches to collect many small amounts from a large number of individuals, crowdfunding has diffused from nonprofit projects to entrepreneurial funding for innovative new ventures. In entrepreneurial funding, the prevailing types are reward-based, lending, and equity crowdfunding[158]. Not only did this new form of funding offer start-ups an opportunity to seek funding, but it also provided opportunities for nonprofit donations and charitable fundraising.

5.1.2. How does crowdfunding work?

The process of crowdfunding begins with the development of a "pitch" that gives information to potential funders. The pitches are hosted in crowdfunding platforms that organise and administrate the whole process and act as a market for fund-seekers to interact with the crowds[159]. The pitch information can take the form of hard facts such as revenue figures or monthly disposable income, or soft claims such as the entrepreneurs' backgrounds and aspirations or promises. However, only some of the presented facts are validated by the crowdfunding platform (for example, some platforms check basic information like credit score, personal income[160]. The average amount of successful campaigns ranged from a few thousand dollars and thus did not compete with institutional investors. Although crowdfunding platforms have grown dynamically in recent years, this new form of funding is not expected to replace traditional tools, but rather to complement them.

Crowdfunding types

Recently, different types of crowdfunding and their variations have appeared. In the following, the four largest, defining types are described.

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[156] Agrawal, A., Catalini, C., & Goldfarb, A. (2015): Crowdfunding: Geography, social networks, and the timing of investment decisions. Journal of Economics & Management Strategy, 253–274.

[157] Allison, T., McKenny, A., & Short, J. (2013): The effect of entrepreneurial rhetoric on microlending investment: An examination of the warm-glow effect. . Journal of Business Venturing, 690–707.

[158] Cholakova, M., & Clarysse, B. (2015): Does the possibility to make equity investments in crowdfunding projects crowd out reward-based investments? . Entrepreneurship Theory and Practice, 145–172.

[159] Bruton, G., Khavul, S., Siegel, D., & Wright, M. (2015): New financial alternatives in seeding entrepreneurship: Microfinance, crowdfunding, and peer-to-peer innovations. Entrepreneurship Theory and Practice, 9–26.

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- In donation type crowdfunding, contributors support a project and receive no or only symbolic rewards in return, as motivation is purely intrinsic[161].
- In reward-based crowdfunding, crowd funders receive nonpecuniary tangible (prototypes) or intangible (experiences) rewards in exchange for their support, being driven by intrinsic (for example, engagement) and extrinsic benefits (for instance, the reward)[162].
- In lending crowdfunding, supporters receive a monetary return in the form of interest, reflecting the risk and duration of the project[163][164]
- In equity crowdfunding, supporters receive a shareholding contract or a revenue-sharing scheme in return for their contribution[165].

The most complex type for backers, requiring their highest involvement, is equity crowdfunding, followed by lending crowdfunding and reward crowdfunding. Donation crowdfunding is significantly less complex and crowd funders' involvement is minimal[166]

Largest crowdfunding platforms

- **Kickstarter:** The most popular crowdfunding site on the Internet, Kickstarter has become a household name. However, it is more for funding inventions and creative works and not for helping nonprofit organisations or funding somebody's endeavors without something in return. Also, participants do not get to keep the money pledged if the Kickstarter goal is not reached.

[161] Gerber, E., & Hui, J. (2013): Crowdfunding: Motivations and deterrents for participation. ACM Transactions on Computer-Human Interaction, 34.
[162] Cholakova, M., & Clarysse, B. (2015): Does the possibility to make equity investments in crowdfunding projects crowd out reward-based investments? . Entrepreneurship Theory and Practice, 145–172.
[163] Allison, T., McKenny, A., & Short, J. (2013): The effect of entrepreneurial rhetoric on microlending investment: An examination of the warm-glow effect. . Journal of Business Venturing, 690–707.
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[165] Cholakova, M., & Clarysse, B. (2015): Does the possibility to make equity investments in crowdfunding projects crowd out reward-based investments? . Entrepreneurship Theory and Practice, 145–172.
[166] Hornuf, L., & Schwienbacher, A. (2014): Crowdinvesting – Angel Investing For the Masses? Handbook of Research on Venture Capital.

- **Indiegogo:** While it tends to play second fiddle to Kickstarter, Indiegogo has several advantages its counterpart doesn't provide. For instance, Indiegogo has flexible funding that lets participants keep the funds they've raised, even when they haven't been able to reach their goal. It also lets them buy funded products in the platform's marketplace, so successful projects have another potential source of income.
- **Patreon:** Another popular crowdfunding platform, Patreon sets itself apart with its subscription model. Instead of being for straight-up campaigns, this is more for providing ongoing financial support for a creative venture or artist. There's also the option to provide content exclusive to patrons who are subscribed to somebody's Patreon through the site itself.
- **GoFundMe:** This one is more popular for individuals who need money right away. They may often see people asking for crowdfunding for short-term projects and medical emergencies in GoFundMe, which is common practice in this platform.
- **Crowdrise:** While not as popular as the platforms mentioned above, Crowdrise has garnered attention for its focus on crowdfunding "real-world issues" over funding for-profit ventures. It can also be used to fund college scholarships, weddings, and even birthday parties. Due to this mostly socially-conscious objective, GoFundMe took notice and acquired it in early 2017[167]

5.1.3. What is the future of crowdfunding?

In less than a decade, crowdfunding has already been recognized as one of the most typical methods of fundraising for innovative products and services. It has assisted millions of innovators and startups in bringing their ideas into the market. The era of non-regulated crowdfunding platforms had already passed, but with the rise of blockchain technology, many new platforms have been incorporated into exotic tax-haven destinations without complying with their respective regulations. Today crowdfunding is mainly conducted based on national legislation, which means that platforms are subject to rules depending on the country where they operate. This makes it difficult for platforms to provide their services beyond borders. The European Union (EU) has already established one-stop-shop access to its market, which helps

[167] Kim, L. (2018): Top 10 Crowdfunding Platforms of 2018. Forrás: https://www.inc.com/larry-kim/op-10-crowdfunding-platforms-of-2018.html

crowdfunding platforms overcome the barriers they face operating cross-border and gives more opportunities to European investors.[168] On the other hand, the regulation of crowdfunding in the United Crowdfunding platforms that are reward-based or for the collection of donations are mostly unregulated, subject only to the prohibitions on fraud and false advertising that apply to all commercial transactions[169]. Internet penetration and the proliferation of smart devices are expected to attract more and more regions and entrepreneurial candidates to the online world. Against this background, crowdfunding platforms are expected to continue to grow in the future and possibly to specialize by topic.

5.2. Business Angels

Business angels or angel investors are, according to specialized literature on the topic, individuals who invest heavily with their means in young, private companies and who during the funding process provide a very high amount of their capital, while not being a friend or relative of the company's founders[170]

5.2.1. A historical perspective

The application of the term "angel" to a kind of investor originally comes from Broadway theater, where it was used to describe wealthy individuals who provided money for theatrical productions that would otherwise have had to shut down[171]. In 1978, William Wetzel, then a professor at the University of New Hampshire and founder of its Center for Venture Research, completed a pioneering study on how entrepreneurs raised seed capital in the US, and he began using the term "angel" to describe the investors who supported them[172]

To understand the benefits of business angels financing, it is necessary to investigate BAs' influential, unique human competences[173]. Start-up business is an essential driver of major innovations in various industries. Despite

[168] Vértesy L. (2019): The legal and regulatory aspects of the free movement of capital - towards the Capital Markets Union. in Jogelméleti Szemle 2019/4. szám

[169] Kostopoulos, N. (2019): Five trends in crowdfunding to watch in 2019. Forrás: https://e27.co/five-trends-in-crowdfunding-to-watch-in-2019-20190211/

[170] Leach, J., & Melicher, R. (2018): Entrepreneurial Finance 6th Edition. Cengage Learning .

[171] Banks, J. (2018). Secure The Bag: How To Be an Entrepreneur. Lulu.com.

[172] Sahay , A., & Sharma, V. (2009): Entrepreneurship and New Venture Creation. India: Excel Books India.

[173] Geibel , R., & Yang, J. (2017): Extended Study on Characterizing Business Angels and Their Impact on Start-up Success . GSTF Journal on Business Review .

this, start-ups often struggle for many reasons to ensure adequate financial means to keep their operation afloat and ensure their survival in a competitive economic environment[174]. Business angels are natural, informal investors that, unlike their VC counterparts, tend to operate in a wider industry sector spectrum and who mostly invest during a company's early stages[175].

5.2.2. How do Business Angels work?

Angel investors are often wealthy individuals who place their money into early-stage entrepreneurial ventures and acting alone or in angel groups. In most cases, business angels help startups with not only capital but also management knowledge, relationship capital, and business advice. We can say, angel investments bear the extremely high risk and are usually subject to dilution from future investment rounds. As such, they require a very high return on investment. Because a large percentage of angel investments are lost completely when early-stage startups fail and go bankrupt, angel investors seek investments that have the potential to return at least ten or more times their original investment. Therefore, it is extremely important to have a defined exit strategy, such as plans for an initial public offering or an acquisition.

Angel investors are increasingly combining to form and join angel groups. During the last 15 years, angel investors have joined different angel groups to get access to quality deals. Angel groups are typically organised by geographic regions in the United States. Top angel groups appear to incorporate around 100-200 members. Some focus on a specific group of industries, while others are more open[176].

5.2.3. What is the future of angel investments?

If you think about it, the aforementioned crowdfunding solutions in recent years have made it possible for a large crowd to become a business angel. These new trends raise the question of whether crowd investing makes the crowd become small business angels, generating thin borders between crowd investors and business angels. On the one hand, there will be crowd investing portals offering minimum investment tickets in the size of angel investments.

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[174] Gregson, G. (2014): Financing new ventures: an entrepreneur's guide to business angel investment. USA, NY: Business Expert Press.

[175] Lerner, J., Pierrakis, Y., Collins, L., & Bravo Biosca, A. (2011): Atlantic drift: venture capital performance in the UK and the US. UK, London: Nesta.

[176] Cremades, A. (2018. September 25.09.2018): How Angel Investors And Angel Groups Work. Forrás: forbes.com: https://www.forbes.com/sites/alejandrocremades/2018/09/25/how-angel-investors-and-angel-groups-work/#3138d94176dc

In this sense, crowd investing and angel finance might be substituted, and the former will ultimately drive down the returns of the latter. On the other hand, there may be scenarios where crowd investors and business angels complement each other, in particular, as some of the latest crowd investing portals are hybrid. Several portals are now more closely integrated with the financial landscape as they work with more traditional investors, including business angels[177]. With the emergence and mutation of digital platforms, we can expect that a significant portion of business angel activities will move to the Internet. However, there is also a part of the classic angel investor role, which is to make personal support, advice, and personal network utilization available to invested start-ups. The question is how digital platforms will enable these very personal roles to be utilized in the online world.

5.3. Venture capital

When a business is born and starts, the owner, or their immediate environment and angel investors tend to provide funding initially. Empirical studies demonstrate[178] that debt financing is not a viable option for this group of companies, the only option for them is (venture) capital financing. At this stage, different types of venture capital sources usually enter.

5.3.1. A historical perspective

Before World War II, banks and the public would buy shares in or lend money to companies with tangible assets or a recurring revenue derived from a retailing business. The problem is that technology-focused entrepreneurial ventures didn't fall into either category. They couldn't borrow from banks because their business model was unknown, and they still had everything to prove. And they couldn't raise capital from the public because no financier could value them. This gap led to the emergence of private equity and venture capital.

The first self-proclaimed venture capital firm was the American Research & Development Corporation (ARD), founded in 1946 by the famous Harvard Business School professor Georges Doriot. As a public company, ARD was able to attract institutional investors in private equity for the first time. Ven-

[177] Hornuf, L., & Schwienbacher, A. (2014): Crowdinvesting – Angel Investing For the Masses? Handbook of Research on Venture Capital.

[178] Bethlendi, András - Urbanics, Roxána (2018): Critical financial and accounting issues of early-stage innovative enterprises. in Investment Management and Financial Innovations 15 : 4 pp. 144-157.

ture capital only emerged as an asset class in the 1970s when it came to financing a new industry: personal computing. As personal computing reached consumer markets for the first time, venture capital grew tenfold in the following years. It was fortunate because a new competition was about to storm onto financial markets: leveraged buyouts—which during the 1980s attracted billions when venture capital deals were still counted in the millions. Fortunately, the 1990s tech bubble provided venture capitalists with a new, larger platform on which they could grow up and dance: the Internet[179].

5.3.2. How does venture capital work?

Where venture money plays an important role is the stage when a company begins to commercialize its innovation. Venture money is not really a long-term funding. The idea is to invest in a company's balance sheet and infrastructure until it reaches a sufficient size and credibility so that it can be sold to a corporation or so that the institutional public-equity markets can step in and provide liquidity. In essence, the venture capitalist buys a stake in an entrepreneur's idea, nurtures it for a short period, and then exits with the help of an investment banker[180].

The stages of venture capital

Even within venture capital, there are investors that focus on different stages therein.

- Seed-stage: it is the initial funding used to establishing a business, or creating a new product or service. Obtaining seed capital is the first stage required for a start-up to become an established business.
- Early-stage: in this stage, venture investors focus on taking a company that has successfully proven its concept to accelerate its sales and marketing efforts. It becomes important to scaling commercial manufacturing and sales.
- Growth-stage: Growth of companies is often exponential by this stage and VC funding serves as a tool for enabling expansion to additional markets and diversification of product lines.

[179] Colin, N. (2016. May 04): https://salon.thefamily.co. Forrás: https://salon.thefamily.co/a-brief-history-of-the-world-of-venture-capital-65a8610e7dc2
[180] Zider, B. (1998): How Venture Capital Works. Harward Business Review, 98611.

There is an extensive literature on the selection and decision-making process followed by venture capital investors.[181] One element of this process is due diligence of financial and taxation issues in the past. In practice since inappropriate financial management can make it more difficult for start-ups to raise capital and, thus, to continue to grow.[182]

The types of venture capital

Within the venture capital space, the two most typically used structures are equity and convertible debt. Equity is issuing common stock or preferred stock (with some type of liquidation preference rights). Once invested, equity is owned outright until some type of sale or liquidity event of the company.

Convertible debt, like its name suggests, is a debt instrument that technically has a maturity date and does need to be repaid at some point in the future. That said, most sophisticated convertible debt investors in venture capital are treating their investment like equity and are prepared to "convert" their debt into equity of the company, upon the company's next equity round. It is often a "bridge" financing to an early stage or growth stage financing, in a way that doesn't have to set a formal equity valuation of the company[183]

5.3.3. What is the future of venture capital?

The amount of capital available for investment depends largely on the economic cycle. If the outlook is favourable, investors will be more open to riskier investments, but if recession approaches, safer investments will come to the fore. However, in the last few years, many changes have taken place with the advancement of the digital world, which can bring about significant changes in venture capital financing. The emergence of crowdfunding sites and blockchain-based platforms are the next steps in this development. They will make a significantly larger sample of companies and asset classes available to a global investor base. It will also be an important challenge to provide not only capital with the help of the online world but also the knowledge and support traditionally provided by venture capitalists to startups. Offering platform services is the one way that VCs have to enhance their reputation and enact positive influence upon their investments outside of the boardroom. (examples of VC platform services include recruiting, marketing, design support, inside sales reps, consulting, accounting services and so forth).

[181] See, for example, Silva, J. 2004: Venture Capitalists' Decision-Making in Small Equity Markets: a Case Study Using Participant Observation. Venture Capital, 6(2-3), 125-145.
[182] Bethlendi András (2019): IKT startup-ok pénzügyi kérdései. Információs Társadalom, 19(2), p. 7–22, 2019.
[183] Deeb, G. (2016. July 18.): forbes.com. Forrás: What exactly is venture capital?

The global economy opened up by the Internet is expected to spark more startup ideas in the future, and the associated funding sources will have to adapt to these trends.

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II. Environmental protection in economic thinking

Gábor Bartus

6. Theory of Sustainability

This chapter focuses on the broader context of the management of the natural environment, i.e. the theory of sustainability, as well as the related political concept of sustainable development, which is an increasingly topical and fashionable issue. We have chosen this topic due to the importance of clarifying to what extent sustainability is a synonym for environmental and nature protection. Politicians, experts, and opinion leaders often use the terms of environmental protection and sustainable development interchangeably, as if they had the same meaning. We will see that although there are many points of contact between the two, there are also significant differences.

6.1. The Challenges of Sustainability

We have taken two fundamental problems of the modern socio-economic system as our starting point. The first one is the tension between savings/investments and consumption. Societies often do not allocate enough funds from their income to the development of their production factors and resources, and the investment rate is not sufficient for the countries to be able to keep up with the performance of other national economies, which are their competitors. Another related problem is the composition of the pool of production factors: nowadays, such factors do not only include human-made capital in the classical sense (e.g. factory buildings, means of production, transport infrastructure), but the future production potential and standard of life are also largely determined by the quantity and quality of three other resources: human, social and natural resources. A common mistake is that the different actors of the society (private investors and governments) develop resources that are not critical to increasing future performance and neglect other resources whose improvement could be extremely beneficial. Some of these differences between the countries are measured by the Global Competitiveness Report/Index of the World Economic Forum, among others.

At this point, we get to perceive how environmental and nature protection and sustainability became connected. It was those noticing the large-scale consumption of the natural capital who first pointed out that when the size of the natural capital was reduced, its lost yield and the ecosystem services would be available in such small quantities or poor quality that it might limit the production potential, restrain the growth of welfare or even lead to the contraction of the economy. Critics perceiving failures in the maintenance of

the natural capital said that that the model of economic growth that resulted in the consumption of the natural capital was not sustainable. If we pollute our groundwater, we cannot brew good beer; if our rivers and lakes are poisoned, there will be no anglers and tourists; if pollinating insects become extinct, we will not have fruits and coffee, and so on.

Later on, the problem of sustainability was given a broader interpretation, and it became clear that the future production potential could be limited not only by the consumption and pollution of natural resources but also by a prolonged decline in the population, high public debt, anarchy (a lack of real governance), a lack of confidence affecting the entire society or the accumulation of implicit debt in social security systems. The indebted future has many manifestations and many different reasons.

Another fundamental problem of modern socio-economic systems—one that is, in many respects, linked to the problems described above—is the tension between the short and long term. Decision-makers—who should make the above-mentioned investment decisions facilitating the maintenance of the future—are influenced by deformed interests. The rules they follow suggest that they should give priority to options that bring substantial benefits in the shortest possible time, regardless of their costs in the more distant future. The above-listed processes leading to an indebted future are frequent because they maximize short-term profit and are able to pass on to the future a large part of the costs associated with them. Increasing public debt is a good solution for politicians because the loans can be used to finance the immediate implementation of impressive development projects or welfare measures, while the installments will be paid by the next governments.

In view of these facts, the problem of sustainability raises two questions:

- What proportion of consumption and investment is required by the adequate development of the resources of society and how should investments be distributed between developments focusing on the different production factors?
- When making our decisions, in addition to short-term consequences (revenues and costs), have we properly taken into account the long-term consequences of the decisions as well?

If these questions had always been relevant in the history of humankind, why did these problems become so serious during the last fifty years that each of them had to be given a separate name?

One of the key substantial changes was the emerging scarcity of the natural capital. The poor management of natural resources had already caused major problems, even the collapse or disappearance of some civilizations (the most widely known examples being Angkor Wat or the Easter Island)[184], but these cases always occurred on a small scale and were separate in space and time (marginal from a global perspective). By the second half of the 20th century, natural resources were becoming scarce even globally. The extension of human activities in geographical terms (land take, changes in land use) and in terms of the quantity of the materials used (at the beginning of the 20th-century average global materials use was approximately 4.5 tonnes per person per year, by the end of the century it increased to 9 tonnes, and according to the OECD's forecast, it is expected to rise to 16 tonnes per person per year by 2060[185]) has reached staggering proportions. The first global assessment report of the UN Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), published in May 2019, presents us with the following data.[186]

As a result of human activities:

- 75 percent of the land has been radically transformed;
- 66 percent of ocean area has changed;
- 85 percent of wetlands have been lost;
- 25 percent of plant and animal species are threatened with extinction;
- over the past 50 years, vertebrate populations have decreased by more than 50 percent.

The report has established that '*[t]he rate of global change in nature during the past 50 years is unprecedented in human history*'.

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[184] Diamond J. (2005): Collapse. How Societies Choose to Fail or Succeed, 2005.

[185] OECD (2019), Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences, OECD Publishing, Paris, DOI:https://doi.org/10.1787/9789264307452-en. and Vértesy L (2010): Gondolatok a fenntartható fejlődésről. in De iuris peritorum meritis 7 - Tanka Endre emlékkötet, Károli Gáspár Református Egyetem, 2010. 15-25.

[186] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.) (2019): Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services, IPBES secretariat, Bonn, Germany, 56 pages, https://doi.org/10.5281/zenodo.3553579.

6.2. Resources to Be Sustained

One of the fundamental theorems of macroeconomics is that welfare products and services, i.e. output (Y) cannot be produced from nothing, because they depend on the quantity and quality of the production factors, or using our terms, resources (K) available to the society:

$$Y = f(K_m, K_h, K_s, K_n)$$

where K_m is human-made physical capital, K_h stands for human resources, K_s is social capital, and K_n denotes natural resources.[187]

Some elements of the resources on which sustainability is based

Physical capital	Human resources	Social capital	Natural resources
Means of production, equipment	Population size and its changes	Quality of the governance system	Raw materials, energy carriers
Infrastructural facilities	Knowledge	Trust between the members of society and trust in the institutions	Ecosystems, biodiversity: carriers of ecosystem services
Financial capital	Health status	Lack of corruption	
	A low degree of inequality and poverty, which does not hamper social mobility	Social inclusiveness	

Table compiled by the author

It is important to know that the conditions for the stability of the long-term and expanding production of the output underlying social welfare in the broad sense depend on space and time, that is, there are no permanent and universal rules for improving the quantity and quality of resources or for determining the proportion of investments in the different types of resources. It depends on the wisdom and sensibility of a given political community and

[187] Based on D. Acemoglu (2011): Introduction to Modern Economic Growth, Princeton University Press, 2011 and Barro and Sala-i-Martin (1995): Economic Growth, McGraw Hill, New York, 1995.

its leaders, whether they recognize the critical resource type whose quantitative expansion or qualitative improvement can contribute most to increasing the output.

However, some features should always be taken into consideration:

- One of the differences between the natural capital and the other three resources is that the natural resources are more difficult to replace, and in some cases, the change may be irreversible: for example, extinct species cannot be brought back to life, and critical changes in the climate may lead to irreversible changes.
- Fairly balanced development is needed (or, in the case of natural capital, the existing resources must be preserved) because it is not enough to have some resource elements that are highly developed even in global terms if other resource elements are lacking or are of very low quality. A persistently high-quality output requires the satisfactory status of all resource elements.
- There is a strong transverse relationship between many resource types. A better-educated society is also generally more health-conscious: people tend to smoke less, do more regular physical exercise, and are, therefore, healthier. In a healthier society, fewer working hours are lost because of sickness-related absence. More highly qualified people tend to be more aware of the environmental impact of their consumption, and a society that is richer in knowledge capital may be more prone to ensure better protection of the natural capital. A society with a constantly shrinking population is also an aging society, where it becomes more difficult to maintain health and funding problems concerning social security (the maintenance of the pension system) may also arise.

For centuries, the resource management pattern of societies was based on the expansion of all resources, but that included the reduction of natural resources. There was a trade-off: the natural capital was reduced (through overfishing in the seas, deforestation, exploitation of soil fertility, over-pollution of the air or water, biologically active surfaces being covered with concrete, etc.), while the other three resources were increased.

$$Y = f(Km, Kh, Ks, Kn)$$

The emergence of the scarcity of natural resources in the second half of the 20th century raised the question of whether it is possible to maintain a persistently high level of output if the amount of natural capital falls below a

critical level. Has the age of the trade-off of natural resources come to an end? Furthermore, if so, is it possible to develop physical, human and social resources in a manner that allows for the replacement of the income benefits that had been previously generated by the exploitation of the natural capital?

In this context, two concepts of sustainability have been developed. The measure of weak sustainability is the persistent non-declining level of output (production potential), where possible. According to the weak sustainability criterion, the trade-off between resources is possible, and the natural capital can be further reduced. However, according to the strong sustainability criterion, any loss of natural capital that would result in a partial loss of Y is prohibited.

Thus, the criterion of weak sustainability is:

$$\delta K(t)/\delta t \geq 0, \text{ for all cases of } t > t(0),$$

where t means time and t(0) is the current moment.[188]

The criterion of strong sustainability suggests that a management system must be developed in which natural resources are replaced and maintained in such a way that, in the long term, the margin of the production potential should not be reduced even if the other production factors remain unchanged at the same time. With this, substitution is forbidden: natural resources cannot become scarce even in themselves, and the expansion of the other three production factors cannot compensate for the possible reduction of natural resources.

Thus, the criterion of strong sustainability is:

$$\delta K(t)/\delta t \geq 0 \text{ and } \delta K_n(t)/\delta t \geq 0,$$

for all cases of $t > t(0)$.[189]

In other words, the above (previously weak) sustainability criterion must also be fulfilled in terms of the natural capital alone, and substitution is only possible between non-natural capital types.

[188] Hanley and G. Atkinson (2003): Economics and Sustainable Development: What Have We Learnt, and What Do We Still Need to Learn? in F. Berkhout, M. Leach and I. Scoones (eds.), Negotiating Environmental Changes: New Perspectives from Social Science, Edward Elgar, Cheltenham, UK

[189] Ibidem.

Weak and strong sustainability

	Weak sustainability	Strong sustainability
Main idea:	The maintenance of resources in general	Natural resources should not become scarce even in themselves
Focus of analysis:	Supporting decision-making through marginal analyses	Absolute magnitude and extent of material and energy use
Method of assessment:	In monetized values	In physical and biological values used in natural sciences
Discounting:	Permitted, but determining the adequate social discount rate is an issue	Disapproved due to ethical reasons; resources must be fairly distributed among generations
Pricing of natural resources:	Prices give an efficient indication of the relative scarcity of resources	Prices are unreliable due to the frequency of externalities
Technological development:	It makes it possible to avoid the reduction of future production potential even when natural resources continue to be used.	It is not a solution because new technologies generate new environmental problems.
Extent of government intervention:	Enforcement of internalisation regulations and the rules of private law	Furthermore, determining the maximum size of the economy and ensuring fair distribution among generations
Role of economic analysis:	Finding the optimal level of natural resource use	The irreversible processes, uncertainty and the stability of ecosystems should also be taken into account.

Source: Hanley, Shogren and White (2007)[190], based on van Kooten and Bulte (2000)[191], in Bartus and Szalai (2014)[192].

[190]Hanley N., J.F. Shogren and B. White (2007): 'Environmental Economics', in Theory and Practice, Palgrave Macmillan, Basingstoke, UK – New York, N.Y., US

[191] Kooten G.C. van and E.H. Bulte (2000): The Economics of Nature: Managing Biological Assets, Blackwell Publishers, Oxford, UK

[192] Bartus and Á. Szalai (2014): Környezet, jog, közgazdaságtan [Environment, Law, Economics], Pázmány Press, Budapest

6.3. The Policy of Sustainability: Sustainable Development

According to its classic definition contained in the so-called *Brundtland Report*[193], *sustainable development* is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This not only imposes on us the obligation to pass on a certain amount of natural resources to the next generations but also requires us to take care of other resources of social existence in the same way.

The principle of *intergenerational equity* or the theory of the *protection of future generations* goes further than the concept of sustainable development by defining moral—in practice, mostly egalitarian—conditions for the conservation of resources for the future. Such conditions would not be strictly necessary to ensure sustainability since the resources that will be used to meet the needs of future generations at that time do not necessarily need to be equal to current resources. According to Brown-Weiss[194], intergenerational equity comprises three principles: (1) the principle of conservation of equal options, (2) the principle of conservation of equal quality, and (3) the principle of conservation of equal access.

Thus, it is clear that the concepts of 'sustainable development' or 'sustainable society' do not have a single meaning that is interpreted and accepted by everyone in the same way. The different interpretations are classified by Bartus and Szalai as follows:[195]

- **Environmental protection 2.0** – Sustainable development is a higher level of environmental protection, where priority is given to the preservation of natural resources for future generations, but the natural capital is conserved using not only traditional environmental protection technologies but primarily by changing the objectives of economic policy and social objectives (e.g. by rejecting economic growth).

[193] United Nations, Our Common Future (1987). UN General Assembly document A/42/427, World Commission on Environment and Development, United Nations, 1987.
[194] Brown Weiss, E. (1992) Intergenerational Equity: A Legal Framework for Global Environmental Change', in E. Brown Weiss (ed.), Environmental Change and International Law: New Challenges and Dimensions, United Nations University Press, Tokyo, 1992. and Brown Weiss E. (2008): A nemzedékek közti igazságosság koncepciója mára elfogadottá vált [The Concept of Intergenerational Equity Has Become Accepted], Interview, Fundamentum, no. 1, 2008, pp. 31–36.
[195] Bartus G. and Á. Szalai (2014): Környezet, jog, közgazdaságtan [Environment, Law, Economics], Pázmány Press, Budapest

- **Potpurri** – Certain sustainability strategies, particularly those of the European Union or its Member States, are elaborated by aggregating or merging existing or planned policy strategies. Here, the actual political content of the label of sustainable development merely consists of the coordination of different policies (climate protection, agriculture, water management, education, transport, etc.) and the use of the language of sustainability.
- **Humanistic/utopian Swiss knife** – It is typical, particularly of intellectuals and some civil society organisations, that they refer to sustainable development as a panacea for all the problems in the world. In this case, the sustainability policy should include an agreed plan for the solution of all kinds of crises and problems. The desired outcome of sustainability policy is a world without conflicts, in which all people (including those who are not yet born) live in harmony.
- **The lingua franca of urging North-South financial transfer** – One of the constant elements of the international dialogue on sustainable development is that, under this principle, countries that are less developed and poorer than average should be given continuous and increasing support. Here, sustainable development becomes a phrase whose different elements become the fixation of groups of countries with different levels of development. Given that, today, countries with richer biodiversity are generally less developed economically, while rich countries have, in many cases, already consumed a large part of their natural capital, the protection of the environment (biodiversity) promoted by rich countries can mainly be attained in poorer countries. The price of achieving this may be financial support. This is how this formula is developed: higher level of environmental protection (e.g. green economy) + financial support for emerging countries = sustainable development.
- **The secret code of anti-capitalism** – Following the almost total fall of socialism in the 1980–90s, critics of capitalism used the arguments of sustainability to reformulate their views. As a result of intergenerational equity, the issue of intra-generational equity, or rather, that of redistributive equality arises.
- **Long-term resource management** – It is a response to two key challenges facing the modern market economy and the democratic institutional system, i.e. shorter time frames for decision-makers and inefficient management of investments in the future. It focuses primarily on the quantitative and qualitative monitoring of resources and, based on this, makes institutional or strategic proposals for improving decision-

making. (As previously analysed, the authors of this publication consider this interpretation to be efficient.)

Therefore, the policy of sustainability (sustainable development) represents the set of actions of the political community that establish appropriate institutional constraints and rules for the conservation and development of resources maintaining their optimum size and proper internal structure.

The National Framework Strategy on Sustainable Development for the period until 2024, was adopted by the Hungarian National Assembly in March 2013. The Framework Strategy highlights the following theoretical options for ensuring sustainability with institutional means:

'Therefore sustainability should be defined in a way that any generation while striving to create their own well-being, [does not exhaust the conditions of individual well-being and the public good,] do[es] not deplete their resources, but conserve and expand them both in terms of quantity and quality for future generations. The interests of those unborn, and therefore without voting right, may only be protected by current generations limiting their own freedom through moral, constitutional or institutional restrictions. Boundaries need to be drawn up, which cannot and should not be crossed, and own freedoms need to be limited in order to not succumb to temptations.'[196]

The prevailing international tasks targeting sustainability are defined by the 2030 Agenda of the United Nations, i.e. the so-called Sustainable Development Goals.[197]

[196] Hungarian National Assembly, National Framework Strategy on Sustainable Development 2012–2024, Resolution 18/2013 (III. 28.) of the Hungarian National Assembly, 2013.
[197] United Nations, Transforming Our World: the 2030 Agenda for Sustainable Development, Resolution adopted by the General Assembly on 25 September 2015 (A/RES/70/1), 2015.

The 17 UN Sustainable Development Goals (2015–2030)

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- Kooten, G.C. van and E.H. Bulte (2000): The Economics of Nature: Managing Biological Assets, Blackwell Publishers, Oxford, UK, 2000.
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Tamás Pálvölgyi, Olivér Hortay

7. Modelling Approaches in Environmental Integration

Tamás Pálvölgyi

7.1. Global, Regional, Multisectoral Modelling

This point gives an overview of the modelling of the phenomena of the **physical (natural) components of the planetary system** (hereinafter referred to as global environmental change), with a particular focus on the processes of climate change and the way it can be modelled[198]. We have given special emphasis to this aspect because the risk of climate change and its socio-economic context are becoming an increasingly inevitable factor in science, politics as well as in business planning and management. The socio-economic 'macro-modelling' of the **human (anthropogenic) components of the planetary system** will be discussed later.

The starting point for the so-called 'world models' was the recognition that natural phenomena and socio-economic interactions form a single system and that no part of this complex interaction system can be designated as an area of research on its own. **The combination of physical, biogeochemical and socio-economic processes is known as the planetary system**.

The processes and interactions of the planetary system cannot be described without taking into consideration human activities. The **main impact factors** of human activities (human influences, pressures) are the following:

- greenhouse gas emissions,
- land use,
- use and pollution of waters,
- emissions of air pollutants.

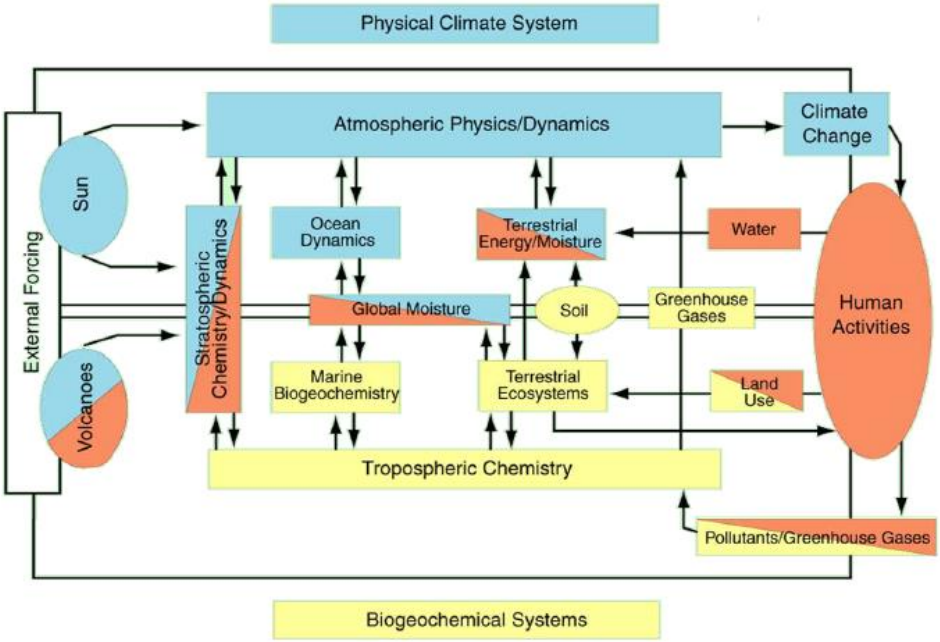
These impact factors are the cause of global changes and the **drivers** of the following global, regional and local phenomena:

- climate change,

[198] A. Buzási, T. Pálvölgyi and M. Szalmáné Csete (2019): K-faktor: Klíma, gazdaság, társadalom [C Factor: Climate, Economy, Society], ISBN 978-963-313-302-6, 2019, https://repozitorium.omikk.bme.hu/handle/10890/13144, accessed 20 November 2019.

- loss of biodiversity,
- environmental health problems (human and animal health).

The main components and processes of the planetary system



Source: A. Szöllősi-Nagy (2019): Klímaváltozás: fókuszban a víz [Climate Change: Focusing on Water], Lecture at the conference of the Association of Climate-friendly Municipalities, Esztergom, 24 October 2019.

7.1.1. The Physical Components and Processes of the Planetary System – How Does the Earth Work?

In view of global environmental changes, the fact that the **wide-ranging substance and energy cycles, as well as the food chain, are closed through the atmosphere** is also of critical importance. With its rapid processes bridging great distances, the atmosphere 'cuts short' feedbacks between other terrestrial systems and provides a direct link between remote areas of the Earth.

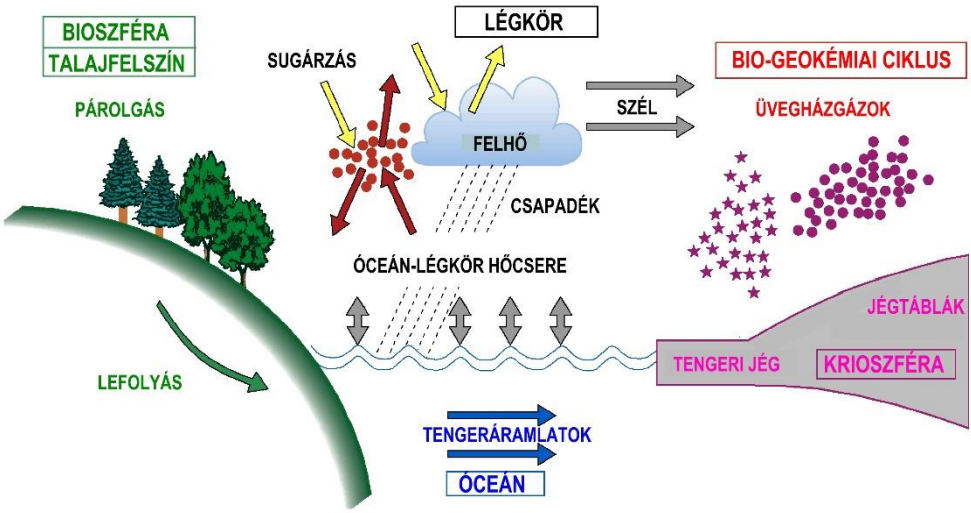
The analysis of long sets of data of different climatic characteristics has led to the conclusion that, in such quantities, there are simultaneous or lagged resonances (so-called 'teleconnections') at relatively remote locations of the Earth. A typical example of this process is the phenomenon known as ENSO (El Niño–Southern Oscillation), in which there is a close link between the

recurrent cold water upwelling along the South-American coast of the Pacific Ocean and the airflow conditions along the Australian coast (air pressure differences, precipitation, extreme weather, etc.). **Thus, the atmosphere—due to its chemical composition and its role in conveying impacts—has a key influence on the state of the other spheres of the Earth.**

A closer look at the current chemical composition of other planets and the chemical composition of 'previous' atmospheres of the Earth reveals that **the presence or absence in the atmosphere of certain substances, whose quantity is minute compared to the planet as a whole, determines the character of the entire global ecosystem.** To take an illustrative example, if there was no carbon dioxide in the atmosphere of our planet—and the total amount of CO_2 in the atmosphere is less than the mass of the Mátra Mountains in Hungary—, the average surface temperature of the Earth would be around -15 degrees Celsius, and the planet would probably be a frozen world without life. Another substance—whose quantity in the atmosphere is even smaller—is ozone, which was indispensable for the biosphere to come into existence and continue to exist on land areas. The total volume of this substance in the atmosphere is estimated at approximately one billionth of the mass of terrestrial biomass. One of the findings of the past 50 years of air observations—an unexpected one—is the existence of a major unidirectional change in the chemical composition of the atmosphere.

Global environmental change and its main form, climate change, constitute one of the most topical socio-economic issues. It has already become clear to both economic and political decision-makers and the people concerned about the environment that such changes—which entail natural disasters, hurricanes, drought and rising sea levels in certain parts of the Earth—pose a serious risk to all the economies of the world. The climate in its broad sense—i.e. the spatial and temporal evolution of the state of the air and of the terrestrial systems interacting with it—is one of the most complex systems ever studied**. The climate system is made up of the atmosphere, the surface of the Earth, the oceans, the biosphere, and the cryosphere. It is a system of mutually interacting factors**, in which the climate of the Earth is determined by the complex set of physical and chemical processes taking place on different temporal and spatial scales. The climate system **can be regarded as a physical (natural) subsystem of the planetary system.**

The components of the climate system



Source: J. Bartholy and R. Pongrácz (eds.), Klímaváltozás [Climate Change], ELTE, Budapest, 2013, bioszféra = biosphere; talajfelszín = soil surface; sugárzás = radiation; légkör = atmosphere; felhő = cloud; szél = wind; bio-geokémiai ciklus = biogeochemical cycle; üvegházgázok = greenhouse gases; csapadék = precipitation; párolgás = evaporation; óceán-légkör hőcsere = ocean/atmosphere heat exchange; lefolyás = run-off; tengeráramlatok = ocean currents; óceán = ocean; tengeri jég = sea ice; jégtáblák = ice floes; krioszféra = cryosphere

From the perspective of climate modelling, the factors and impacts determining the climate can be divided into three major groups:

1. The **extraterrestrial impacts** include changes in the radiation of the Sun, which control the climate system, as well as the effect of astronomical bodies causing ebb and flow, and the cosmic particles entering the gravitational field of the Earth.

2. The **terrestrial impacts** consist of the interactions between the four spheres of the Earth:

- **Surface of the Earth**: It includes the arrangement of the continents, plate tectonic movements and the terrain. Soil characteristics, vegetation types, and the extension of free water surface are slowly changing factors, while soil moisture, vegetation cycles, and snow and ice cover are factors that change rapidly.
- **Oceans**: Besides the atmosphere, the role of oceans is the most significant due to the fact that 97% of the Earth's water resources are located

in the oceans, as well as due to their high heat capacity and the characteristics of their fluid mechanics systems.

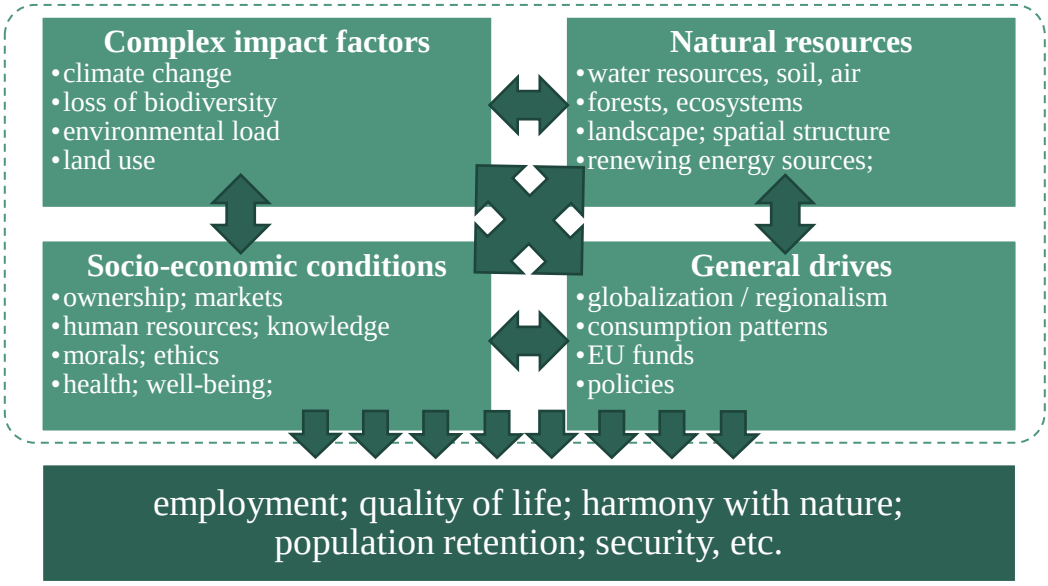
- **Cryosphere**: The snow and ice cover of the Earth is made up of the seasonal snow cover of land areas, the ice caps and ice sheets of the continents, the glaciers of mountains, and sea ice. The heat transfer between the cryosphere and the atmosphere, as well as the cryosphere's capacity to reflect radiation, are considerable.
- Biosphere: The role of flora, fauna and human activities is mainly reflected in the CO_2 cycle and in the release of various aerosols into the atmosphere.

3. The most important of the **factors inside the atmosphere** is its capacity to absorb and/or reflect radiation, which is closely related to the development of the greenhouse effect. Air chemical processes (interactions of ozone, CO_2, water vapor and different aerosols with the atmosphere and with each other) and the dynamics of the atmosphere (creation and development of atmospheric motion systems of different scales from small dust devils to general circulation) are also essential. The interactions between the components of the climate system can be broken down into positive and negative feedback processes: the first ones enhance, while the latter mitigate changes. Feedback mechanisms related to heat/ice albedo, water vapor and clouds are the most important in terms of global warming.

7.1.2. The Process and Trends of the Greenhouse Effect – A Key Factor in Global Changes

The world's population is growing by one billion per decade. In the last two centuries, global energy demand has increased by approximately 2% per year. The energy and food needs of the developing world grow by 1–2% per year, while the population of developed countries is constantly aging. The revolution in the chemical industry in the past decades has led to the creation of some 5 million synthetic compounds, the use and elimination of which (e.g. residues accumulated in the food chain, microplastics) greatly aggravate the environmental condition of the Earth. If the current trends remain unchanged, two-thirds of the species on the Earth could become extinct by 2100. The drivers of global environmental change are closely related to other complex processes, which are also global in nature.

System of relations of global environmental change



The modelling of the planetary system absolutely requires that the **process of greenhouse effect** be understood from a physical perspective—its causes from a socio-economic perspective—and described in mathematical terms. It has been known theoretically since the end of the 19th century and through reliable measurements since 1958 that the carbon dioxide, methane and nitrous oxide content of the atmosphere is rapidly increasing as a result of the use of fossil fuels, decreasing forest areas and large-scale agricultural activities.

The Physical Background to the Greenhouse Effect

When the rays of the Sun reach the Earth's surface, a part of the energy is absorbed, thus warming the soil and the oceans. The remaining energy is reflected in outer space, but a part of it is absorbed by the atmosphere, thus raising further the temperature of the planet. This is known as the 'greenhouse effect', since the atmosphere behaves like the glass walls of a greenhouse, keeping the interior space warm. The greenhouse effect is caused by the presence of gases such as water vapor, carbon dioxide, methane and nitrous oxide (known as greenhouse gases) in the Earth's atmosphere. Without this natural greenhouse effect, the average temperature of the surface of the Earth would be approximately 33 degrees Celsius lower than at present; therefore, **the greenhouse effect is a natural process that is vital to life on**

Earth. (**This is why these compounds cannot be labeled as 'harmful substances'**, since it is not their atmospheric presence that causes problems but their increasing quantity.)

The evolution of the quantity of the main greenhouse gases in the atmosphere over the past 200 years

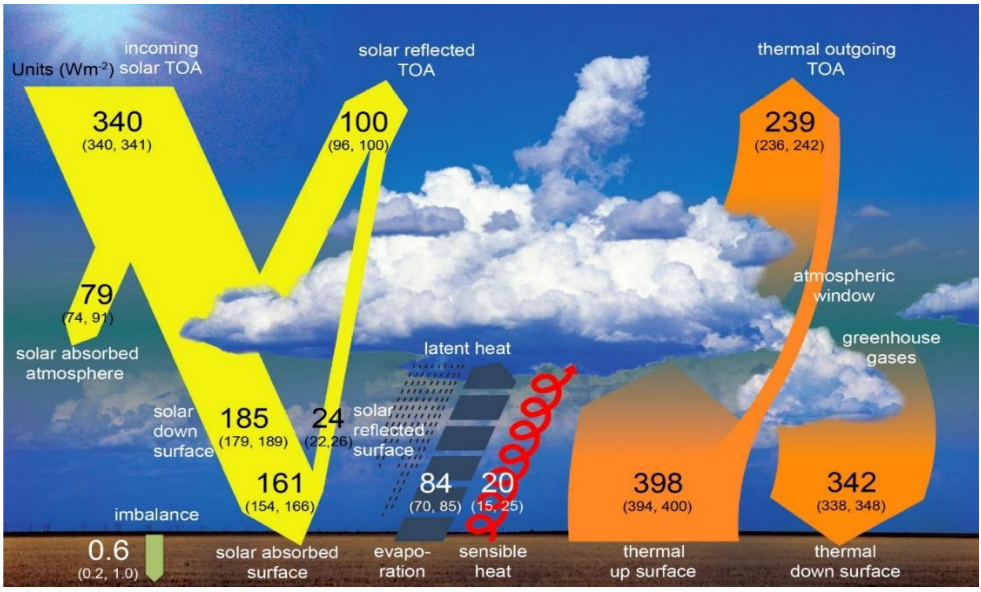
	CO_2 (carbon dioxide)	CH_4 (methane)	N_2O (nitrous oxide)	HFC (halo-fluoro-carbon)	PFC (per-fluorocarbon)	SF_6 (sulphur hexafluoride)
concentration before the industrial revolution	280 ppm	700 ppb	275 ppb	-	-	-
current concentration (2014)	405 ppm	1,830 ppb	350 ppb	0.15 ppb	0.07 ppb	0.05 ppb
growth rate of concentration	0.4 % per year	0.8% per year	0.3% per year	7% per year	2% per year	?
average residence time in the atmosphere	50–200 years	8–15 years	120 years	50–200 years	approx. 3,000 years	3,200 years
global warming potential (GWP) (on a scale of 100 years)	1	23	298	1,400–15,000	6,000–15,000	22,000

Source: IPCC, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland, 2014, pp. 1–31.

Currently, the carbon dioxide content of the atmosphere is more than a third higher than before the industrial revolution, primarily due to the increasing use of fossil fuels and extensive deforestation. Through the natural process—through the carbon dioxide absorption processes of plants and oceans, among others—, this gas is released into the atmosphere and then gets out of it in much larger quantities than those mentioned above. This means that human activities have **upset the natural dynamic balance (the natural circulation of carbon dioxide and other substances)** in such a way that natural carbon sinks are no longer able to absorb the extra carbon dioxide released into the atmosphere by non-natural means. The release into the atmosphere of one new methane molecule increases the greenhouse effect 23 times as much as a carbon dioxide molecule, the release of a nitrous oxide molecule 300 times, while some halogenated hydrocarbon molecules tens of thousands of times as much.

Increased greenhouse gas emissions lead to a change in the thermal system of the atmosphere, a so-called **radiative forcing**. The spatial distribution of solar energy and its evolution in time are the primary drivers of all weather and climate processes. A part of the energy reaching the outer limits of the atmosphere is reflected by clouds, the surface and the solid particles suspended in the atmosphere, and—taking into account the atmospheric absorption as well—approximately half of the energy reaches the surface of the Earth. A part of the infra-red thermal radiation emitted by the warmed-up surface is absorbed and reflected by clouds and the greenhouse components of the atmosphere, thus ensuring the balance between net incoming radiation and outgoing thermal radiation over a long period of time and on the whole of the Earth. Thus, considering the Earth-atmosphere system as a whole, **greenhouse gases do not 'heat' our planet** but change the structure of the vertical distribution of temperature by causing the lower layers of air to warm up and the higher ones to cool down.

Atmospheric radiation transmission and the greenhouse effect



Source: IPCC, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland, 2014, pp. 1–31.

The exploration of the greenhouse effect mechanism is not the result of the past few decades but of nearly one and a half centuries. As early as the 1860s,

scientists studying the atmosphere recognized the important role of trace gases in the pleasant climate of the Earth. In 1861, the first article by John Tyndall[199] about the role of water vapor in heating the atmosphere was published in the English Philosophical Magazine. The study written by Svante Arrhenius in 1896 described the expected atmospheric consequences of the increasing concentration of carbon dioxide due to coal burning.[200]

Unlike greenhouses used in horticulture, the atmospheric greenhouse effect has some 'special characteristics':

- air and cloud particles absorb a large proportion of solar radiation;
- in a certain range (known as the 'atmospheric window'), the Earth radiation passing through the atmosphere towards outer space is not absorbed by greenhouse gases;
- the winds carrying air masses also play a major role in the free atmosphere;
- the warm air cannot pass through the glass plate, but there is no such obstacle in the atmosphere (convection).

Greenhouse Gas Emission Trends Globally and in Hungary

Approximately 50% of the anthropogenic CO_2 emitted since 1750 was released into the atmosphere in the last 40 years. Despite climate change mitigation policies, **global CO_2 emissions doubled from 1975 to 2015**. The contribution of CO_2 emissions from fossil fuel combustion and industrial processes to the overall increase of greenhouse gas emissions amounted to nearly 80% from 1975 to 2015.

Anthropogenic greenhouse gas emissions depend basically on population, economic activities, lifestyle, energy use, land use, technologies, and climate policy. There are several emission reduction pathways, which are probably able to keep the level of warming below 1.5 °C compared to pre-industrial levels. These pathways would all require substantial cuts in emissions over

[199] J. Tyndall (1861): 'On the Absorption and Radiation of Heat by Gases and Vapours, and on the Physical Connexion of Radiation, Absorption, Conduction.–The Bakerian Lecture', The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, series 4, vol. 22, pp. 169–194, 273–285.

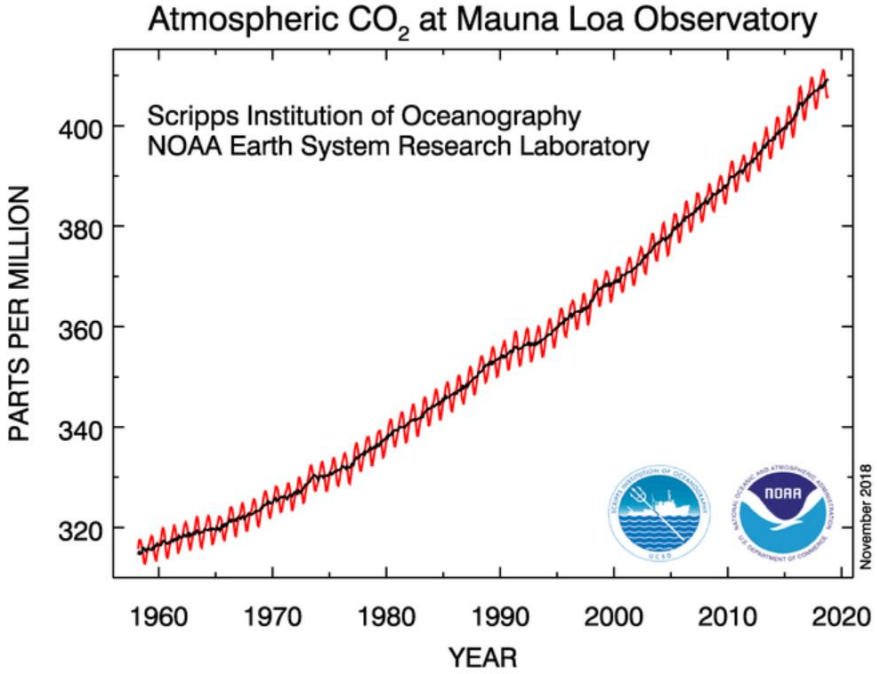
[200] J. Bartholy and R. Pongrácz (eds.) (2013:, Klímaváltozás [Climate Change], ELTE, Budapest, 2013, http://elte.prompt.hu/sites/default/files/tananyagok/Klimavaltozas/index.html, accessed 20 November 2019.

the next few decades as well as the reduction of CO_2 and other greenhouse gases with a long residence time to almost zero by the 2050s.

Without further efforts going beyond the current reduction in greenhouse gas emissions, as a result of global population growth and the increasing economic activities, global emissions are expected to continue to grow. According to the baseline scenarios—which do not include emission reductions exceeding the cuts achieved so far—, by 2100, the global average temperature is expected to increase by 3.7–4.8 °C compared to the average temperature of the period from 1850 to 1900.

The evolution of CO_2 concentration and the required emission cuts

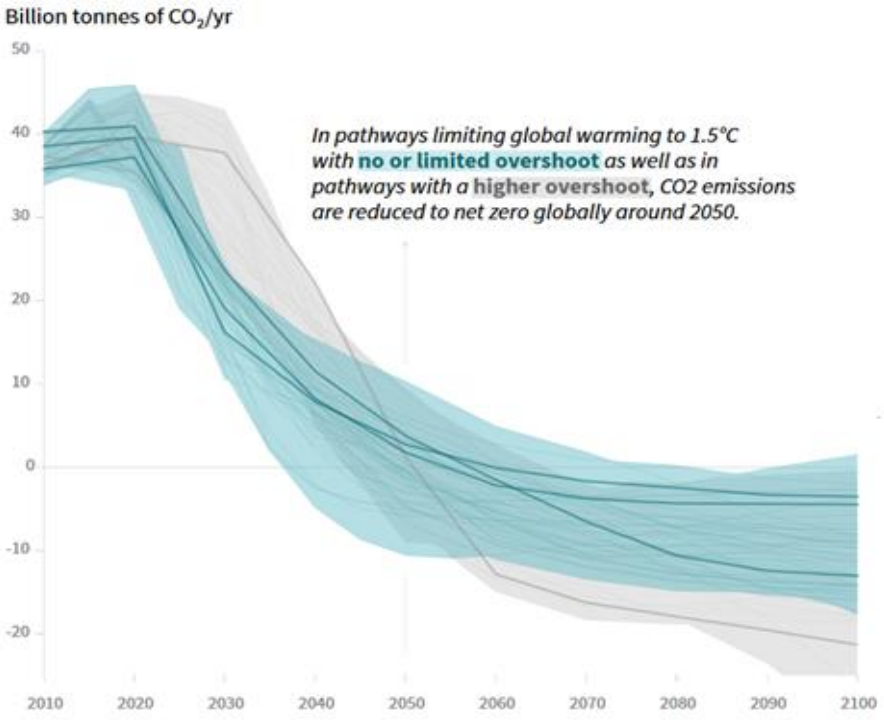
Measurement data of atmospheric CO_2 concentration (past)



NOAA, https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html, accessed 20 Nov. 2019.

The quantity of CO_2 in the atmosphere is rising steadily, and it has already reached the highest level of the last 800,000 years. The scientists agree that **the most dangerous irreversible consequences of climate change can be avoided if the increase in the global average temperature does not exceed 1.5 °C.** However, for this to happen, **GHG emissions should be reduced by at least 55% worldwide by 2030**, and net-zero emissions would be the target for 2050.

Potential CO_2 emission pathways limiting global warming to 1,5 °C (future)

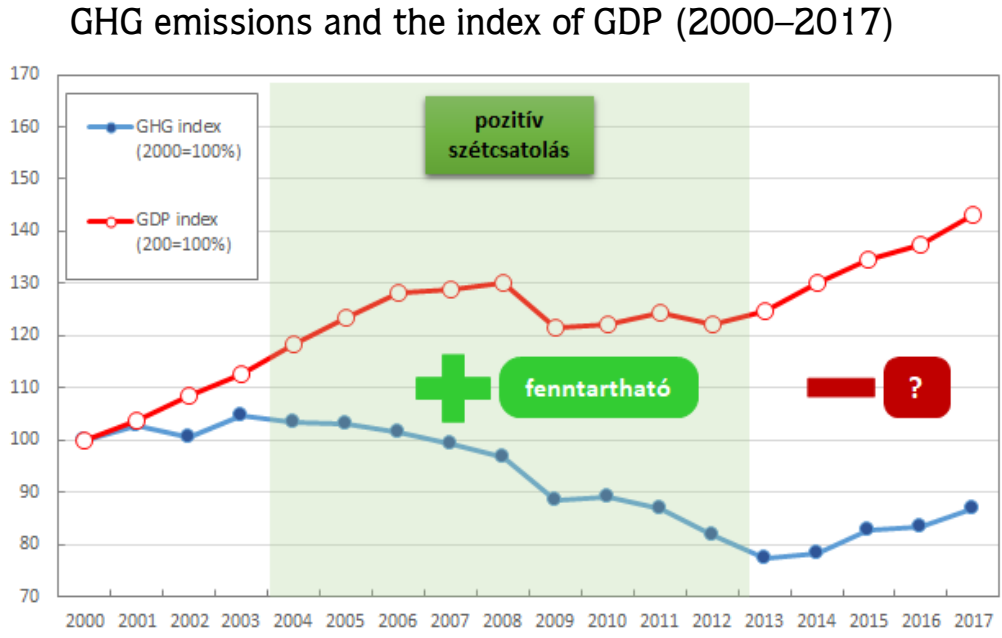


IPCC, 'Summary for Policymakers', in *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, 2018, https://www.ipcc.ch/pdf/special-reports/sr15/sr15_spm_final.pdf, accessed 15 November 2018.

In 2017, Hungary's greenhouse gas emissions amounted to approximately 64 million tonnes of carbon dioxide equivalent[201], which constitutes a nearly 40% fall compared to the early 1990s. 6 tonnes per capita emissions are relatively low in Europe (the EU average is 9 tonnes per capita). The most important greenhouse gas is still carbon dioxide, which accounts for 78% of total emissions. The main source of carbon dioxide emissions is fossil fuel combustion in power stations, households and transportation. Methane accounts for 12% of Hungary's total GHG emissions, while nitrous oxide for approximately 7%. The main sources of these two compounds are agriculture

[201] NIR (2019): National Inventory Report for Hungary 1985–2017, Hungarian Meteorological Service and National Food Chain Safety Office, 2019, https://unfccc.int/sites/default/files/resource/hun-2019-nir-15apr19.zip, accessed 20 November 2019.

and chemical production. The analysis of emissions per sector reveals that the energy sector accounts for exactly three-quarters of the total emissions. Agriculture accounts for 12.1%, industrial processes for 12.3% and the waste sector for 5.8% of greenhouse gas emissions. From the 1990s to the early 2010s, GHG emissions were continuously decreasing, mainly due to the transformation of the structure of the economy (the decline of the energy-intensive heavy industry). However, **since 2013 GHG emissions in Hungary have been increasing by 3–5% per year**, which draws attention to the importance of measures concerning energy efficiency and transportation.



Source: edited by the author on the basis of data from NIR, *National Inventory Report for Hungary 1985–2017*, Hungarian Meteorological Service and National Food Chain Safety Office, 2019, https://unfccc.int/sites/default/files/resource/hun-2019-nir-15apr19.zip, accessed 20 November 2019.
pozitív szétcsatolás = positive decoupling; fenntartható = sustainable; GHG index = GHG index; GDP index = GDP index

7.1.3. Climate Modelling

Climate modelling, i.e. the mathematical description of the climate system on the basis of physics, plays a key role in the modelling of the planetary

system.[202] Climate may be one of the most complex phenomena ever studied; therefore, climate research requires cooperation between geophysics, atmospheric physics, oceanography, astronomy, and according to the most recent views, even biology, as well as the synthesis of their findings.

Studies of recent decades have demonstrated that changing climate is the natural state of the climate system, which is comprised of the atmosphere, the oceans, the continents, the polar ice caps, and the biosphere (see above). This feature, characteristic in both space and time, is what creates the diverse global climate, including tundra and the tropics, as well as ice ages and warm periods between them. One of the causes of **climate variability** lies in the nature of the interactions within the climate system: it can be assumed that our climate environment is a so-called **chaotic dynamic system**, in which processes changing the state of the system can take place, within certain limits, 'by themselves', without any external influence. The other cause of climate variability is **forced variability**. In this perspective, changes in the state of the climate system are caused by oscillations and trends in the chemical composition of the atmosphere, the extent of solar and volcanic activity and the polluting activities of technical civilization. This double nature of temporal climate behaviour raises the question of **whether the climate of the future can be known at all**.

The time scale selected for the examination of climate change is crucial for finding an answer to this question. If we opt for the geologic time scale and put the question of what the climate of our planet will be like in 50 million years' time, the answer is clearly 'no': we cannot adequately describe either the future of these forced processes or the unpredictable, chaotic variability. However, if the question refers to **how the climate will evolve in a few decades (perhaps centuries), we can give a probable answer,** because it is fairly unlikely that in the next century a chaotic phenomenon comparable to the climatic consequences of the greenhouse effect and possibly neutralizing it will occur. In other words, if the pace and extent of unidirectional changes in the greenhouse trace gases of the atmosphere to be expected in the coming decades were known precisely, then theoretically, it would be possible to give a probable forecast for the (forced) changes in the climate. **The tool used for this 'if-then' type of climate studies is the climate model.** These mathematical models based on physics are only capable of taking into con-

[202] J. Bartholy and R. Pongrácz (eds.) (2013): Klímaváltozás [Climate Change], ELTE, Budapest, 2013, http://elte.prompt.hu/sites/default/files/tananyagok/Klimavaltozas/index.html, accessed 20 November 2019.

sideration a relatively narrow (albeit growing) range of interactions. We cannot disregard the fact that the causal relationships identified (including 'model forecasts') are surrounded by scientific uncertainty that is difficult to estimate, which is aggravated by the practical impossibility of testing the viability of these models.

The purpose of climate models is to describe **the interactions of the processes of the climate system**; they simulate the movements in the atmosphere and oceans and estimate the expected evolution of temperature, density, and air pressure. They describe the elements of the hydrological cycle as well as the expansion and melting of polar ice caps and glaciers. They provide approximations of cloud and precipitation formation processes.

An important issue in climate forecast is to establish to what extent a model is able to give an accurate description of the average behaviour of the climate system (e.g. the atmosphere or oceans), regardless of the prediction of the occurrence of specific weather events. In practice, this refers to how much the simulated climate changes compared to the average (mostly compared to a reference climate). **Climate can thus be characterized by statistical indicators**: multi-annual monthly average, average annual precipitation levels, etc. However, the atmosphere is highly sensitive to the baseline conditions due to its non-linear, turbulent and locally chaotic nature, which means that small initial errors in the model can lead to major forecast and simulation errors. Therefore, a single categorical forecast alone has limited validity, since the forecast should be completed with the probability of its viability in order to ensure that as much information is available to users as possible. Rough model results, generally, cannot be used directly; therefore, they must be subject to additional statistical and/or dynamic adaptation procedures or post-processing operations.

All modern **climate models include the atmosphere, land surface, oceans and sea ice** as sub-models. The atmospheric and ocean modules are general circulation models containing both a thermodynamic and a hydrodynamic description, which explicitly simulate the fluid mechanics of the given medium.

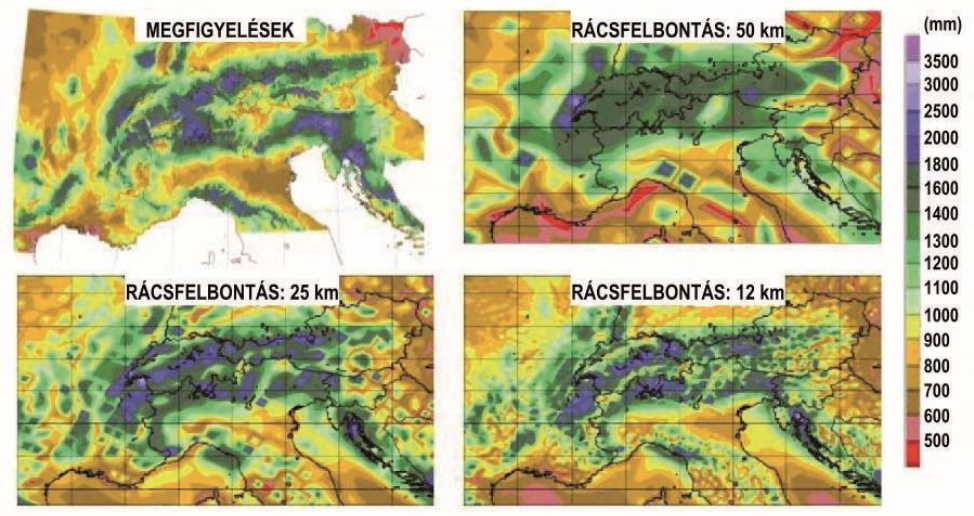
Atmospheric General Circulation Models (AGCM)

Generic circulation models describing atmospheric processes are computer programs that can be used to simulate the temporal evolution of the three-dimensional state of the atmosphere (i.e. of the fields of different state indicators). This requires the definition of the conservation laws that can be ap-

plied to the hydro-thermodynamic processes of the atmosphere, or more precisely, their approximation using mathematical equations (partial differential equation system). The state indicators used are temperature, air pressure, fluid motion rate (a three-dimensional vector quantity), and the density of the various phases of water vapor and water (cloud and precipitation elements). The models define the state indicator fields, considered to be continuous, using a multi-layer grid. The grid resolution is usually determined by computer capacity. As the whole atmosphere can be regarded as a single thin spherical layer, the vertical distance between grid lines is usually two orders of magnitude smaller (~0.1 to 1 km) than the horizontal distance (~10 to 100 km). Some of the processes determining atmospheric movements (which are generally at least one order of magnitude larger than the distance between grid lines) can be described well using this grid, while others cannot. The latter are known as **subgrid-scale processes**.

The overall impact of such processes is represented in the model by parameterizations. Today, practically all AGCMs are based on this parameterization approximation, which can only manage the convectional upstream and downstream processes (e.g. cumulus clouds, thunderstorms, organised convection) by means of parameterization. Each AGCM must include a so-called radiation module describing the short- and long-wave radiation transmission processes in the atmosphere. These processes are determined by the absorption, dispersion and emission of atmospheric gases and aerosol particles. Each AGCM contains parameterization for the description of subgrid-scale processes. The spatial and temporal scales of these processes—taking into consideration local cumulonimbus clouds or giving an approximation for the heat exchange between the soil and the atmosphere—are too small to be described directly using the model's grid.

The impact of the resolution of the models on the evolution of estimated precipitation fields and of the observed annual precipitation



Source: J. Bartholy and R. Pongrácz (eds.), Klímaváltozás [Climate Change], ELTE, Budapest, 2013, http://elte.prompt.hu/sites/default/files/tananyagok/Klimavaltozas/index.html, accessed 20 Nov. 2019. megfigyelések = observations; rácsfelbontás = grid resolution

Ocean General Circulation Models (OGCM)

Similarly to the atmosphere, the World Ocean's water circulation models (OGCMs) are based on an approximation of the mathematical formulae of conservation laws. The fundamental difference between the two flowing media, i.e. the atmosphere and the ocean, is that while **the atmosphere can be compressed, the ocean is essentially incompressible.** However, the water of the World Ocean – which is approximately 3–4 km deep on average – can not be regarded as totally incompressible. One reason for this is the pressure of 300–400 bars deep down in the ocean, which significantly alters the density of water. The second reason, which plays a much more important role in the development of the ocean circulation system, is the fact that if the temperature and salinity change, the density of seawater also changes. This is why **the global water circulation of the ocean is called thermohaline circulation**. In the attached climate models, OGCMs – similarly to AGCMs – constitute only a sub-module of the entire coupled model. The couplings consist of the balance of momentum, heat and water vapor flows between the atmosphere and the ocean, and of the heat flows and salt concentration be-

tween the ocean and sea ice. Similarly to the atmosphere, the horizontal dimensions of the ocean are also three orders of magnitude larger than its vertical dimensions. However, as the density of seawater is three orders of magnitude higher than the density of the atmosphere, the forces and mechanisms determining horizontal and vertical flows are less separated than in the atmosphere. With its three large ocean basins, the continents as impenetrable barriers, narrow straits and significant differences in the terrain of the seabed; the geometry of the ocean is completely different from the geometry of the atmosphere, which should be taken into consideration by modelling. **Due to the salinity-related differences in density, the thermodynamics of the ocean is very complex, and we only have approximate knowledge of the seawater's equation of state.**

Similarly to the large-scale eddies of an average size of a few thousand kilometers (cyclones and anticyclones) in the atmosphere, the ocean also has its geostrophic ring eddies of 10 to 100 km, which transfer a significant amount of energy. They are usually located along frontal zones separating cold and warm water masses (e.g. the border zone between the Gulf Stream and the Labrador Current), just like their counterparts in the atmosphere. However, ocean eddies are not included explicitly in any of the current ocean models, only in a parameterized form. Currently, their integration into OGCMs in a direct form is the biggest challenge in the field of ocean modelling, since this would significantly reduce uncertainties concerning the mixing and transportation processes.

Sea Ice Models

Each AOGCM contains a sea ice sub-model even though, in most models, the continental ice sheet is included only as a constraint. The models include the elements of sea ice dynamics and thermodynamics alike: the physics of ice movements, heat and salt transfer processes within the ice as well as between the ice and the surrounding seawater. While in reality, sea ice is made up of floes that are 10 to 10,000 m wide and only a few meters (<10 m) thick, the models regard sea ice as a single ice sheet. The descriptions rely on the appropriate exact physical theory, known as rheology, which studies the relationship between shear stress and the movements and deformation caused by it. Ice models greatly vary in terms of their thermodynamic description. The models divide the sea ice cover into different parts horizontally (e.g. shore-fast ice, drift ice, etc.). The grid network of sea ice models is usually the same as the grid network of the underlying ocean model (i.e. it is based on ocean models, just like biosphere models are based on soil models). The albedo of snow and ice surfaces—the proportion of the solar radiation they

reflect—plays a very important role in the climate system; therefore, the scientists developing the models strive to parameterize this mechanism ever more precisely.

Olivér Hortay

7.2. Macroeconomic Models

The core task of macroeconomics is to identify the main processes underlying the long-term growth of economies, to explore their complex mechanisms of action and to forecast their future evolution. As climate change is expected to have a significant impact on economic output in the future, both globally and regionally, it should be considered in growth models. The greatest difficulty concerning implementation is that chemical and physical processes affecting climate change must be added to the social processes constituting the main focus of economics, which requires a complex, interdisciplinary approach.

The foundations for the integration of two large and rather complex areas, i.e. economic growth and climate change, were laid by William D. Nordhaus, who received the shared Nobel Prize in Economic Sciences in 2018 for his scientific work in this field. The model developed by Nordhaus in the 1990s allows for the integration of climate change caused by human activity into previous growth models. The purpose of this subchapter is to present Nordhaus's basic model. The background to the model—previous growth models serving as a starting point and the evolution of the integration of climate change—will be described briefly. This will be followed by a detailed discussion of the basic regional model and its global extension, including its simplifications and constraints. The sub-chapter will conclude with the presentation of the results of Nordhaus's early model and its policy implications. The sub-chapter draws heavily on the book of Nordhaus and Boyer, published in 2000[203], in which the original DICE model (Dynamic Integrated model of Climate and the Economy)—improved continuously by Nordhaus in the 1990s—and its regional version, the RICE model (Regional Dynamic Integrated model of Climate and the Economy) are described by the authors in detail.

[203] W.D. Nordhaus and J. Boyer (2000): Warming the World: Economic Models of Global Warming, Cambridge, MA, The MIT Press.

7.2.1. The Background to Models Integrating Economic Growth and Climate Change

An event of outstanding importance in terms of resource management was the 1973 oil crisis (and the preceding report by the Club of Rome[204]), which directed the attention of a large number of economists to the natural resources, which could potentially limit economic growth. In an article published in 1974, Robert M. Solow—whose thesis written in the 1950s[205] had played a decisive role in the growth theory of that period—expanded his original model with the use of exhaustible natural resources, following the rule previously proposed by Harold Hotelling[206]. In the same year, William D. Nordhaus gave a graphic description of the changes in economic thinking, which is perhaps the most important antecedent to the model presented in this sub-chapter.[207] In his famous example, Nordhaus stated that while previously a kind of 'cowboy' approach had been prevalent in economics, which regarded natural resources to be inexhaustible compared to the extent of their use, economic growth had already reached a level where economists had to switch to a 'spaceship' approach, according to which resources were exhaustible and had to be appreciated.

With the progress of ecological research in the 1970s and 1980s, in addition to the fear of the exhaustion of resources, other factors that could affect long-term economic growth also emerged and had to be addressed by economists. Climate change is one of the global problems, and it continues to be very relevant. The problem poses two main challenges for economists: firstly, they have to analyse the potential impacts of climate change on economic growth, and secondly, as the reduction of greenhouse gas emissions—which are the reason for climate change—is costly, they have to make a proposal on the types and timing of the required interventions. One of the first integrated macroeconomic models used for assessing the economic impacts of climate change was the DICE model, whose partial results were presented by Nordhaus on several fora from 1990 onwards, and he also published them in

[204] D.H. Meadows, D.L. Meadows, J. Randers and W.W. Behrens III (1972): The Limits to Growth: A Report for the Club of Rome's Project on The Predicament of Mankind, New York, Universe Books

[205] R.M. Solow (1956): A Contribution to the Theory of Economic Growth, Quarterly Journal of Economics, vol. 70, 1956, pp. 65–94.

[206] H. Hotelling (1931): The Economics of Exhaustible Resources, Journal of Political Economy, vol. 39, no. 2, 1931, pp. 137–175.

[207] W.D. Nordhaus (1974): Resources as a Constraint on Growth, American Economic Review, vol. 64, 1974, pp. 22–26.

a single framework, in a summarised form in 1994[208]. The model integrated a number of innovations in economic thinking, but it also received technical criticisms. The RICE model, in which the global model is made up of various regional modules, was created on the basis of such criticisms, and later on, it was the starting point for the work of several researchers involved in the study of the economic impacts of climate change and the possible interventions.

Although the DICE model was published earlier than the RICE model, the first one faded into the background after the publication of the latter. One reason for this is that the world's regions are very different; therefore, the economic impact of climate change can be assessed more precisely—which is the main objective of these models—by considering them separately and then aggregating the results. The other reason is that the separation of regions allows for addressing the issues concerning the optimal use of fossil fuels—whose concentration is geographically different—and the optimal allocation of carbon dioxide emission allowances between countries and periods. In general, the DICE model is a simplified version of the RICE model and is more of historical importance. Accordingly, the following section will provide a detailed description of the RICE model.

7.2.2. Specification and Global Extension of the RICE Model

From a mathematical perspective, the RICE model is an optimization algorithm, whose objective function is the maximization of the prevailing social welfare of the region considered, and its limiting factors are the equations describing economic and natural relationships. Since the model is intended to capture very complex interrelationships with many components that are difficult to define mathematically, simplifications and assumptions have to be applied. These will be discussed at a later point, together with the specification of the model. The equations of the model can be divided into four groups: relationships concerning the objective function, the economic relations and the impacts of climate change, as well as the optimum in the market of fossil fuels. This section describes the model's equations in this order.

Objective Function

The first problem that arises with regard to the objective function is the definition of social welfare. One part of the problem is a static measurement

[208] W.D. Nordhaus (1994): Managing the Global Commons: The Economics of the Greenhouse Effect, Cambridge, MA, The MIT Press

difficulty regarding how welfare can be quantified, while the other part—which derives from the fact that the model examines long time spans and several periods—concerns the question of how the conversion of values between periods can be managed, i.e. how the model can be dynamized. The RICE model addresses the measurement-related difficulty of the first problem using the concept of 'generalized consumption', which is commonly used in macroeconomics. This means that the model assumes that the operators of the economy can produce and consume a single type of goods; thus, investments can also be used to increase the production of the good concerned. In this way, the changes concerning this single good provide an indication of the changes in social welfare.

From an economic perspective, the question of the trade-off between different periods is one of the key problems of the efforts aimed at reducing climate change. The main dilemma refers to the number of goods that society should renounce in order to ensure that the production potential of future generations is preserved. Each generation in each period has to decide what proportion of the goods meant to be invested is used to increase productivity and how much is used to mitigate climate change. The first group of goods produces a larger amount of consumable goods but greater climate risks in the next period, while the latter leaves an unchanged amount of goods and lower climate risks for future generations. The RICE model includes a so-called discount factor for addressing the problem of intertemporality, which represents the society's willingness to make trade-offs between periods. On this basis, the objective function of each region considered can be described with the following formula:

$$W_J = \sum_t U\left[c_J(t), L_J(t)\right] R(t)$$

W_J stands for the social welfare of region J, which needs to be maximized during the optimization process. $c_J(t)$ represents the per capita consumption of region J during period t, while $L_J(t)$ is the size of its population. $U\left[c_J(t), L_J(t)\right]$ is the utility of consumption, while $R(t)$ stands for the discount factor, which is the same for all regions. The model aims to maximize the sum total of discounted utilities over all the periods of the entire time span considered, in a regional breakdown. With regard to the utility function, the RICE model assumes that higher levels of consumption generate greater utility and that there is the diminishing marginal utility of consumption as consumption increases. The utility function of consumption—also known as the economic value of welfare—is obtained by multiplying the size of the

population of the given period $[L_J(t)]$ by the utility of per capita consumption, which can be interpreted as follows:

$$U\big[c_J(t), L_J(t)\big] = L_J(t)\frac{c_J(t)^{1-\alpha} - 1}{1-\alpha}$$

In this equation, parameter α is the elasticity of the marginal utility of consumption, i.e. the selection of this parameter determines the curvature of the utility function. The empirical DICE and RICE models assume a limit value of $\alpha = 1$, which yields the following utility function, the so-called Bernoullian utility function:

$$U\big[c_J(t), L_J(t)\big] = L_J(t)\{log\big[c_J(t)\big]\}$$

The key parameter of the utility function is the population, whose future evolution is calculated by the model on the basis of the initial population of the region $[L_J(0)]$ and the rate of population growth $[g_J^{pop}(t)]$ as follows:

$$L_J(t) = L_J(0)exp\left(\int_0^t g_J^{pop}(t)\right)$$

When the RICE-99 model was elaborated, population forecasts predicted a declining growth rate, therefore, choosing it as a constant proved to be ineffective. For this reason, the model calculates the growth rate on the basis of an initial growth rate $[g_J^{pop}(0)]$ and a constant rate of decline $[-\delta_j^{pop}]$, which varies from one region to another, as follows:

$$g_J^{pop}(t) = g_J^{pop}(0)exp\big(-\delta_j^{pop}t\big)$$

In the empirical model, the initial growth rate was 1.5% and the maximum global population, also known as the population limit of the given period, was 11.5 billion.

According to the assumption related to the discount rate, taking the same population size and per capita consumption, the marginal social utility of consumption is higher. The original empirical model operates in periods of ten years, in which flow variables are reported as flows per year, while stock variables are measured at the end of the period. The discount rate depends on the pure time preference of society $[\rho(v)]$ as follows:

$$R(t) = \prod_{v=0}^{t}[1 + \rho(v)]^{-10}$$

Due to the long time period considered, the selection of the pure time preference (or discount rate) has a significant impact on the results of the model. In the first DICE model, Nordhaus used a constant discount rate of three percent, but later this was strongly contested by other researchers. Many research results on the human perception of time show that the social discount rate declines as the time span increases. Accordingly, one of the improvements made to the model was the dynamization of the discount rate with a constant rate of decline $[-g^{\rho}t]$; thus the corrected version uses the following equation:

$$\rho(t) = \rho(0)\exp(-g^{\rho}t)$$

In the empirical model of 1999, the discount rate $[\rho(0)]$ starts at 3 percent in the initial year of 1995 and declines to 2.3 percent in 2100 and to 1.8 percent in 2200.

Economic Relationships

The RICE model calculates the economic output of the region using the Cobb-Douglas production function, which is the most commonly used function in traditional growth models. One of the innovations of the model is that, in its production function, the output $[Q(t)]$—in addition to the capital stock $[K(t)]$, labour $[L(t)]$ and technology $[A(t)]$, which are traditionally taken into account—is also affected by energy services from the combustion of fossil fuels $[ES(t)]$, as well as their unit costs $[c_J^E(t)]$. Another innovation of this model is the integration of a so-called 'damage coefficient' $[\Omega_J(t)]$ into the production function, which represents the impact of climate change on economic output. The production function can, therefore, be formulated as follows:

$$Q_J(t) = \Omega_J(t)\left\{A_J(t)K_J(t)^{\gamma}L_J(t)^{1-\beta_J-\gamma}ES_J(t)^{\beta_J} - c_J^E(t)ES_J(t)\right\}$$

The production function has three parameters that can be calibrated: γ is the elasticity of output with respect to changes in capital and β_J is the elasticity of output with respect to changes in energy services. In this model, technological progress is reflected in two different ways: in productivity growth and in the improvement of energy conversion efficiency. $A_J(t)$ indicates the exogenously increasing productivity, whose future evolution—similarly to population—is influenced by a region-specific and time-varying parameter reflecting the growth rate $[g_J^A(t)]$ as follows:

$$A_J(t) = A_J(0)\ exp\left(\int_0^t g_J^A(t)\right)$$

There is significant uncertainty concerning the projection of the future evolution of productivity. The RICE model assumes that the improvement of productivity will slow down. The growth rate for the period considered can be calculated on the basis of its initial value $[g_j^A(0)]$ and a constant rate of increase $[-\delta_j^A t]$ as follows:

$$g_j^A(t) = g_j^A(0)exp\left(-\delta_j^A t\right)$$

Another type of technological development is related to the improvement of energy conversion efficiency. The energy service $[ES(t)]$ included in the production function is calculated by multiplying the amount of fossil fuels used $[E_J(t)]$ by their conversion factor $[\varsigma_J(t)]$.

$$ES_J(t) = \varsigma_J(t)E_J(t)$$

In this model, the growth of energy generating technologies that do not produce carbon dioxide emissions is taken into account through the increase of the conversion factor. Similarly to the population and productivity, the conversion factor is predicted with the following equation including a time-varying growth rate parameter $[g_J^Z(t)]$ and a constant rate of increase $[-\delta_j^Z t]$:

$$\varsigma_J(t) = \varsigma_J(0)\ exp\left(\int_0^t g_J^Z(t)\right)$$

$$g_J^Z(t) = g_J^Z(0)\ exp\left(-\delta_j^Z t\right)$$

The main difference between the DICE and RICE models is that while the DICE model considers the entire world economy and its emissions to be a single agent, in an aggregate manner, in the RICE model, regions can trade their carbon dioxide emission allowances. In growth models that assume a traditionally closed economy—due to the generalized consumption concept—the region considered uses one part of the economic output (or the GDP produced) $[Q_J(t)]$ for consumption $[C_J(t)]$ and the other part for investment $[I_J(t)]$. In the RICE model, potential revenues and costs deriving from the trading of carbon dioxide emission allowances are added to the available emission allowances. The model does not examine other types of commercial activities. Therefore, the budgetary constraint of the region concerned is as follows:

$$Q_J(t) + \tau_J(t)\left[\Pi_J(t) - E_J(t)\right] = C_J(t) + I_J(t)$$

$\Pi_J(t)$ is the number of allowances allocated to the region and $\tau_J(t)$ is the unit cost of carbon dioxide emissions. It is important to note that the RICE model primarily regards energy carriers as fossil fuels, and thus provides the value of the parameter $E_J(t)$ on the basis of its carbon content, which means that the fuel used is equal to its carbon content. Energy use, therefore, reduces the amount of carbon dioxide emissions available to a region. As in this model fossil fuels are represented in terms of both quantity and price by a parameter each; during the empirical implementation, the estimation of such parameters should be done by the weighted aggregation of different technologies.

Depending on whether the region considered uses more or less carbon than it is entitled to, its budgetary constraint may decrease or increase. The $\tau_J(t)$ unit cost parameter can be interpreted both as the price of the carbon dioxide emission quota and as the Pigovian tax payable for carbon dioxide emissions. The RICE model assumes that emission trading between regions is efficient, thus the price of carbon dioxide emissions is equalized, and its value is at least zero.

The region's total consumption can be calculated by multiplying per capita consumption by the population size:

$$C_J(t) = c_J(t)L_J(t)$$

In order to determine the amount of capital available to the region considered during a given period, the capital stock of the previous period must be reduced by a depreciation rate δ_K. The empirical RICE model assumes that the capital depreciates at 10 percent per year, and since investment is measured at annual rates, the depreciation should be adjusted to the ten-year period as follows:

$$K_J(t) = K_J(t-1)(1-\delta_K)^{10} + 10 \times (t-1)$$

The production function includes the cost per unit of the region's energy service $[c_J^E(t)]$, which is the sum total of the world market price of energy $[q(t)]$, which is assumed to be equalized globally, and a markup $[markup_J^E(t)]$, which is different in each region. In the RICE model, the markup captures the costs of energy transportation and distribution, the amount of which is assumed to be constant over time. The improvement of transportation and distribution technologies is represented by the increase of the previously discussed productivity.

$$c_J^E(t) = q(t) + markup_J^E(t)$$

The first DICE and RICE models used fixed energy costs on the basis of the explicit assumption that the available stocks are inexhaustible. However, this was strongly criticized in the related literature, as the stocks of fossil fuels—which are at the center of the model—are limited, and due to the considered time period of two hundred years, the depletion of the stocks may have a significant impact on world market prices. In the improved models, world market prices for energy are determined on the basis of each region's energy demand. The cumulative energy demand [$CumC(t)$] related to global economic output can be calculated as the sum of the demand registered at the end of the previous period and the annual demands adjusted with the 10-year period:

$$CumC(t) = CumC(t-1) + 10 \times \sum_J E_J(t)$$

As the RICE model focuses on fossil fuels, which are available to a limited extent, the model expects that, in the future, at a certain amount of global demand [$CumC^*$], there will be an inflection point in the extraction costs of energy carriers, beyond which their marginal costs will begin to rise. Accordingly, the world market price for energy is calculated with the following equation:

$$q(t) = \xi_1 + \xi_2 \left[\frac{CumC(t)}{CumC^*}\right]^{\xi_3}$$

ξ_1, ξ_2 and ξ_3 are fit parameters, whose modification allows for the energy supply curve to be estimated on the basis of empirical observations and expectations. Due to the overall growth framework of the model, operators efficiently allocate their use of energy sources, thus the empirical model confirms the intuition, and low fossil fuel prices increase over time.

7.2.3. Modelling the Impacts of Climate Change

The main difficulty in defining the damage coefficient [$\Omega_J(t)$] of the production function is that there is very limited experience concerning the interaction between climate change and economic output (during the elaboration of the models, this problem was aggravated by the limited data available). For this reason, during the development of the DICE and RICE models, the way greenhouse gases were addressed changed significantly. The early version

was intended to model all greenhouse gas emissions in an endogenous manner. However, reactions to the initial model led to improvements: industrial carbon dioxide emissions became the exclusive focus of the model, thus the 1999 RICE model described herein considers the emissions of other types of carbon dioxide (e.g. related to land use) and other greenhouse gases to be exogenous.

Another major change—between the initial and the improved DICE and RICE models—in terms of the modelling of climate change is the more complex consideration of the carbon cycle. The first models used an empirical approach to estimating the flows related to the dispersion and absorption of carbon dioxide, but the critics pointed out that the dispersion properties of carbon dioxide are different in each reservoir. Therefore, the 1999 model examines three different reservoirs for carbon: the atmosphere, the upper oceans and the biosphere, and the deep oceans. The empirical model assumes that each of the three reservoirs are well-mixed in the short run, while the mixing between the upper reservoirs and deep oceans is assumed to be slow in the long run. In the RICE model, the increase of the concentration of carbon dioxide and its mixing between the reservoirs can be described with the following equations:

$$M_{AT}(t) = 10 \times ET(t-1) + \phi_{11} M_{AT}(t-1) + \phi_{21} M_{UP}(t-1)$$

$$M_{UP}(t) = \phi_{22} M_{UP}(t-1) + \phi_{12} M_{AT}(t-1) + \phi_{32} M_{LO}(t-1)$$

$$M_{LO}(t) = \phi_{33} M_{LO}(t-1) + \phi_{23} M_{UP}(t-1)$$

$M_{AT}(t)$ is the end-of-period mass of carbon dioxide in the atmosphere, $M_{UP}(t)$ is the mass of carbon dioxide in the biosphere and the upper oceans, while $M_{LO}(t)$ is the mass of carbon dioxide in the deep oceans. $ET(t)$ is the total global carbon dioxide emissions in the period considered, which not only includes the endogenous industrial emissions discussed in the previous sub-chapter but other exogenous emissions as well. Coefficients ϕ_{ij} are the transfer rates from emitting reservoir i to sink j, where $i \; and \; j = AT, UP \; and \; LO$.

In the improved model, the impact of the increased concentration of carbon dioxide on climate change is addressed by introducing 'radiative forcing' F(t), which depends on the amount of carbon dioxide in the atmosphere and the effects of other greenhouse gases and aerosols $[O(t)]$, as follows:

$$F(t) = \eta \left\{ \frac{log\left[\frac{M_{AT}(t)}{M_{AT}^{PI}}\right]}{\log(2)} \right\} + O(t)$$

M_{AT}^{PI} is the pre-industrial level of atmospheric concentration of carbon dioxide, which is assumed to be 280 ppm (parts per million) in the empirical model. The model uses the change in the global mean temperature $[T(t)]$ to represent climate change and calculates it with the following equation:

$$T(t) = T(t-1) + \sigma_1\{F(t) - \lambda T(t-1) - \sigma_2[T(t-1) - T_{LO}(t-1)]\}$$

$T_{LO}(t)$ is the mean temperature in the deep oceans in the period considered, and it is calculated as follows:

$$T_{LO}(t) = T_{LO}(t-1) + \sigma_3[T(t-1) - T_{LO}(t-1)]$$

In these two equations, λ is a temperature feedback parameter, while σ_i is the transfer coefficient reflecting the thermal capacities of the different reservoirs. Nordhaus illustrates the role of the two parameters through the example of a warming container. The container is heated by a light source from a specific point above (in the equation, this force is $F(t)$), and the heat reaching the surface of the substance in the container (e.g. water) gradually diffuses to the lower parts. The lags in the warming of the lower layers are determined by thermal inertia.

The next task in producing the damage coefficient of the model is to quantify the economic damage $[D_J(t)]$ caused by the change of the global mean temperature, for which Nordhaus uses the following simple quadratic polynomial, whose parameterisable coefficients are $\theta_{1,J}$ and $\theta_{2,J}$.

$$D_J(t) = \theta_{1,J}T(t) + \theta_{2,J}T(t)^2$$

The use of the quadratic polynomial is motivated by the assumption that the effects of the change in the global mean temperature are not linear, i.e. the increment of the rising mean temperature causes even greater damage. Finally, the economic damage caused by climate change becomes the following damage coefficient, thus it can be integrated into the production function.

$$\Omega_J(t) = \frac{1}{1 + D_J(t)}$$

We can see that the economic value of the damage is in the denominator, therefore, its increase reduces the value of the coefficient. The reason for this is that the impact of climate change appears as a negative factor limiting the production potential.

7.2.4. Equilibrium in the Market of Fossil Fuels

One of the important issues of the model is the amount of fossil fuels extracted by each region in each period. The equations described above did not address extraction decisions made between periods that are of key importance due to the exhaustible nature of energy carrier stocks, nor the quota prices achieved in the market of carbon dioxide emission allowances. For that to happen, in addition to the previously described variables, an $h(t)$ parameter is introduced to represent the costs related to the timing of extraction under the Hotelling rule[209], along with the previously obtained quota price $[\tau_J(t)]$. On this basis, a rearrangement of the production function can be used to describe the equilibrium as an equation, with the left side representing the demand for fossil energy and the right side representing energy costs. Regarding the latter, the costs related to the timing of extraction and the costs of the carbon dioxide emitted during the combustion of energy carriers will be added to the market prices previously considered.

$$\beta_J \Omega_J(t) A_J(t) K_J(t)^{\gamma} L_J(t)^{1-\beta_J-\gamma} ES_J(t)^{\beta_J-1} = c_J^E(t) + \frac{h(t)}{\varsigma_J(t)} + \frac{\tau_J(t)}{\varsigma_J(t)}$$

As we have already seen, the energy service $[ES_J(t)]$ can be calculated by multiplying the fuels used by the conversion efficiency $[\varsigma_J(t)]$. By inserting these terms into the above equation and then transforming it, we can calculate the equilibrium fossil energy use of the region and period considered.

$$E_J(t) = \left[\frac{1}{\varsigma_J(t)}\right] \left\{ \frac{c_J^E(t) + \frac{h(t)}{\varsigma_J(t)} + \frac{\tau_J(t)}{\varsigma_J(t)}}{\beta_J \Omega_J(t) A_J(t) K_J(t)^{\gamma} L_J(t)^{1-\beta_J-\gamma}} \right\}^{\frac{1}{\beta_J-1}}$$

The first term of the equation shows that the energy demand can be reduced by increasing the conversion parameter (i.e. by improving efficiency). Since the elasticity parameter β_J can be in the range between 0 and 1, the exponent

[209] H. Hotelling (1931): The Economics of Exhaustible Resources, Journal of Political Economy, vol. 39, no. 2, 1931, pp. 137–175.

of the second term of the equation will be negative. Accordingly, increasing costs reduce, while growing demand increases equilibrium fossil energy use.

7.2.5. Results and Conclusions of the Model

Compared to the DICE model, the main innovation of the RICE model is that—in addition to the macroeconomic effects of climate change—it is also able to forecast the impact of carbon dioxide emissions reduction policies. Accordingly, three types of scenarios can be created on the basis of the results: a scenario without interventions (where regions do not apply a carbon dioxide reduction policy), a non-cooperative scheme (where regions set their policies with the aim of maximizing the welfare of their region), and a cooperative approach (where the regions' optimization efforts aim to maximize global welfare)[210].

The results show that the policy interventions aimed at reducing carbon dioxide emissions lead to greater welfare, but their impact varies widely across regions. The carbon tax is most effective in developing countries, whose welfare increment by 2100 will be close to USD 50 billion under the non-cooperative scenario or USD 350 billion under the cooperative approach (using USD values of 1990). Scenario runs show that co-operation leads to a higher optimal carbon tax (or an equilibrium quota price), which will exceed USD 20 per tonne after 2050 and will reach USD 30 per tonne by 2100 (under the non-cooperative approach, it will not reach USD 2 by 2050 anywhere), and it will significantly improve global welfare growth. Policy interventions are the least profitable for the US, which is the only region whose interests are not furthered by co-operation. The model represents climate change through the increase of global mean temperature, which will be close to 3 degrees Celsius by 2100, and the choice between the three scenarios has a relatively small influence on it. Developing countries have the most pressing need for interventions. In those countries, in the period from 2030 to 2050, annual cumulative discounted consumption without a carbon tax will be more than 40 percent less than the same consumption calculated with cooperative interventions.

Therefore, the main conclusions of the original RICE model suggest that although in the period considered the carbon tax (or the equivalent tradeable emission allowance) could only reduce global warming, its economic impacts are highly positive both globally and in most of the regions considered.

[210] W.D. Nordhaus and Z. Yang, 'A Regional Dynamic General-Equilibrium Model of Alternative Climate-Change Strategies', The American Economic Review, vol. 86, no. 4, 1996, pp. 741–765.

An important conclusion is that climate change affects each region differently, and it has the strongest impact on countries that are lagging behind in terms of economic development. Finally, the coordination of the policy interventions of the different regions can greatly increase social welfare both in most regions and globally; therefore, there is huge potential in successful international negotiations and agreements.

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Gábor Bartus

8. Environmental Economics

Maintaining the output level requires natural resources and their ecosystem services as well. For a long time, until the middle of the 20th century, environmental resources seemed to be infinite and inexhaustible, i.e. not requiring any sort of management. However, humanity had to face the limits of nature ever more frequently as it turned out that natural resources were indeed finite, and their scarcity made itself increasingly felt. In the 20th century, environmental economics emerged as a new school of economics. The intellectual starting point for the representatives of this school is *The economics of welfare*, a monograph by Arthur Cecil Pigou, first published in 1920, or more specifically, one or two paragraphs of this book, where the well-known English economist argues that, in order to ensure optimal and efficient output, taxes must be imposed on products that generate external costs through environmental pollution. In other words, environmental economics deals with the different aspects of the management of natural resources, particularly, of the use of the yields of the natural capital in economic management and of the emissions into the natural environment (waste and pollution).

It must be emphasized that, on this theoretical basis, it becomes evident that the problem of environmental pollution and the overexploitation of natural resources is not just an ecological issue but an economic problem as well and, in most cases,, the cause of losses.

8.1. The Subject and Methodology of Environmental Economic Analysis

Environmental economics is the study of border offenses in the interactions between society and the environment. When the starting point and the end result of an interaction, as well as all elements and effects of the process, remain within the ecosystem, these phenomena constitute the subject of biology, ecology, and natural sciences in general. If the interactions take place within the society, they will be studied by social sciences, such as economics. However, there are processes in which the society and the natural environment are connected as a result of our activities.

Input-side connections occur when the society uses the elements of nature as raw materials, resources, and the material flow goes from nature towards society. Environmental economic analysis, therefore, considers nature as a capital and the yields of this capital as an ecosystem service. This analytical part is called the economics of natural resources. It also addresses issues that constitute a major problem today, such as: To what extent does the practice of intensive agriculture exhaust soil fertility? How many trees in a forest can be felled? Can the forest coverage of the Earth be reduced? (Let us think, for example, of the protests against forest burning in Brazil in 2019.) Will the lithium stocks of the Earth be sufficient to allow for a total transition of mobility to electric vehicles using batteries?

Output-side connection occurs when the material flow goes from society towards nature. This part of environmental economics is called the economics of pollution. Should climate change be stopped? On what scale and at what speed should greenhouse gas emissions be reduced? What kind of deterioration of health is caused by high levels of nitrogen oxide or solid particles in urban air? What are the risks of high-level radioactive waste (spent fuel of nuclear power stations), i.e. what is the reasonable cost of building an appropriately safe depot for such waste?

8.1.1. Environmental Economic Analysis

Environmental economics studies the connections between the economy and its environment (use of natural resources in the economy, discharge of the by-products and waste of the economy into the environment) and analyses them on the basis of the axioms and with the analytical methods of economics.[211]

Characteristics of environmental economics

	Environmental economics
As a discipline	part of the paradigm of economics; extension of the methodology and theses of economics to the relationship between the economy and the environment
Methodology	methodological individualism, analytical approach (marginal analysis, equilibrium models)
Management of natural resources	the conservation of resources is necessary to improve and maintain the welfare of individuals
Assessment	based on individual preferences, anthropocentric, instrumental

[211] G. Bartus and Á. Szalai (2014): Környezet, jog, közgazdaságtan [Environment, Law, Economics], Pázmány Press.

Scarcity	Ricardian relative scarcity
Maintenance of the natural capital	'weak' sustainability: the natural and human capital can generally be substituted
Biogeochemical limits of the economy	marginal role
Technological development	innovational optimism: technical progress contributes to the solution of environmental problems

Source: Venkatachalam, 2007212, in: Bartus-Szalai 2008.

8.1.2. The Approach of Ecological Economics

Ecological economics is a methodologically and normatively separate approach to the economic analysis of environmental issues. In many respects, it can be regarded as a part of environmental economics, while from another perspective, it can be viewed as a school that is in dispute with the approaches of environmental economics.[213] The initial aim of ecological economics was to create an integrated theory providing a framework for describing and explaining the phenomena of the economy in their context, taking into account all their interplays with the environment. In other words, ecological economics intended to achieve a systematic integration of 'traditional' economics, the economics of pollution, the economics of natural resources, and ecology.[214] According to ecological economics, these four analytical methods and theories—which have been isolated so far— should be integrated so that the issues of the economy and its environment can be considered as parts of a whole.

Ecological economics places a clear emphasis on the fact that the economy is only a part of the natural system, i.e. the truths and constraints of natural sciences necessarily apply to the economy as well. Therefore, a key issue of ecological economics is the aggregate size of the economy and the establishment of the maximum possible level of economic activity.

[212] L. Venkatachalam (2007): Environmental Economics and Ecological Economics: Where They Can Converge?', Ecological Economics, vol. 61, 2007, pp. 550–558.

[213] Sub-chapter 3.1.2 is practically based on one of my previous articles: Bartus, 2008. G. Bartus: Van-e a gazdasági tevékenységeknek termodinamikai korlátja? [Do Economic Activities Have a Thermodynamic Constraint?], Közgazdasági Szemle, vol. 55, November 2008, pp. 1010–1022.

[214] R. Costanza (1989): 'What is Ecological Economics?', Ecological Economics, vol. 1, 1989, pp. 1–7.

As the creation of a theoretical framework integrating the different sub-disciplines as well as the integration of ecology and economics suffered a setback, during the development of this methodological difference, the expression of the criticism of economic growth as a normative difference was given more emphasis. The approach of ecological economics also attaches greater weight to the analysis of the links and correlations between environmental problems and inequalities in terms of income, wealth and access to natural resources.

Characteristics of ecological economics

	Ecological economics
As a discipline	partial rejection of the paradigm of traditional economics, intention to integrate ecology and economics
Methodology	methodological pluralism, holistic view, transdisciplinary and horizontal approach
Management of natural resources	resources are valuable in themselves; other species have the same right to survival as man
Assessment	it seeks to give an approximation of the intrinsic value of the individuals and elements of the ecosystem
Scarcity	Malthusian absolute scarcity
Maintenance of the natural capital	'strong' sustainability: the stock of natural capital cannot decrease
Biogeochemical limits of the economy	a central role in terms of analysis and theory
Technological development	technological skepticism: new technologies generate new environmental problems
Welfare and equality	commitment to egalitarian views, equal access to resources—in addition to size and efficiency—is a fundamental issue

Source: Venkatachalam, 2007, in: Bartus, 2008.

Ecological economics underlines that the current economic system is unable to distinguish between changes in size and growth, on the one hand, and quality improvement and development, on the other. Furthermore, it is also unable to adequately address two fundamental issues: allocation (equality) and the establishment of the optimal size of the economy in its entirety.

In general, the representatives of the ecological school argue for interpreting sustainability in its strict sense, underlining that the substitution of natural capital goods for knowledge or technological capital leads to the devaluation of natural assets. They believe that the conservation of natural capital is a prerequisite for the proper maintenance of human capital since man cannot

live without their biological environment. Maintaining biodiversity is, therefore, a priority. For this reason, determining the economic value of the 'services' provided by the environment constitutes an important area of research.

8.2. Efficient Level of Environmental Use

The overexploitation of the natural capital—either on the side of the use of natural resources as inputs or on the side of material flows going from the economy towards the environment in the form of pollution and waste—has now become well documented as a result of regular ecological assessments and examinations, which have been going on for decades.[215] The reason for the inefficient use of the environment is that most effects (benefits or costs) related to the use of nature appear outside the market. The effects outside the market are, however, generally ignored by economic operators in their decisions, as they do not appear as a value (price signal) for them.

Externalities occur when[216] the exchange of a given good in the market affects not only the two parties involved in the exchange, i.e. the seller and the buyer (e.g. the power station generating electricity and the consumer using electricity at home), but other parties as well (the acid rain caused by the sulfur dioxide emissions from the power station reduces the yields of a forest holding), and such third parties derive additional benefit or damage from the production, market sale, exchange or consumption of the given good. In this case, the society's benefit is not only what the buyer and the seller gain, but it should also include the benefit and damage of the said party not taken into consideration (the so-called third party).

The results (benefits or costs) ignored in market transactions distort market allocation. Market allocation is, in principle, the most efficient way of performing the basic task of economic management: allocating scarce resources to production and consumption options in a way that ultimately ensures that the sum total of the utility of such resources for individuals is as high as

[215] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.), Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services, 2019, IPBES secretariat, Bonn, Germany, https://doi.org/10.5281/zenodo.3553579.

[216] In this chapter, externalities and the efficient level of environmental use are explained following the argumentation of one of our previous textbooks, see in detail Chapter 5 of Bartus and Szalai, 2014.

possible. However, such efficiency can only be achieved if all the factors affecting social welfare become price signals. The producer (seller) is faced with all production costs, and their marginal willingness to accept is defined by such costs together. At the same time, the consumer (buyer) is faced with all the costs related to consumption, which define their marginal willingness to pay. Finally, the willingness of many sellers and many buyers creates a dynamic balance between supply and demand, thus establishing the quantity of goods being exchanged in the market and the transaction price.

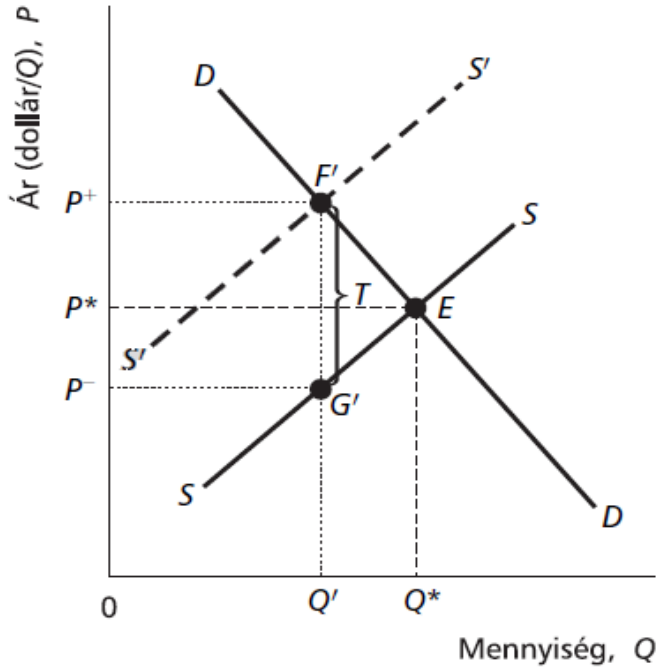
In the previous example of electricity put on the market in the exchange between the power station and the consumer, several costs of electricity generation appear as part of the supply function, such as the price of energy carriers and the wages of the employees of the power station, but—unless there is government intervention, e.g. a tax on Sulphur dioxide emissions—the loss of the forest holding caused by the Sulphur dioxide emissions of the power station is not included therein. Thus, it will not be part of the willingness to accept, i.e. the supply function. The existence of acid rains—which are caused by Sulphur dioxide emissions—will probably not affect electricity consumers' willingness to pay and, thus, the demand function. In this way, there will be a cost related to the exchange of a good in the market that is not included either in the supply or in the demand function, which means that the equilibrium quantity and price will be determined without taking into account this cost.

The following figure shows the social loss, thus caused by externalities and the efficiency drop in market allocation. The independent variable (Q) is usually the physical quantity of a given good, while the dependent variable (P) is the price. Neither the demand function (D) nor the supply function (S) includes the cost incurred by the third party, i.e. the externality. The diagram also includes the hypothetical supply function S', whose difference from S is T, which is the size of the externality. This function would include the cost of sulfur dioxide emissions, either as the cost of the desulfurization equipment or as the compensation paid to the forest holding. (Let us imagine, for example, that the company that owns the power station acquires the forest holding, and the management of the holding company realizes that they incur losses due to their own activities. Then, probably, they will find a solution to maximize the profits of both companies; thus the supply of the power station may change.)

The welfare loss caused by externalities can thus be seen in the diagram. The quantity that changes hands will be Q', instead of Q*, and the price to be paid

will be only P*, instead of the P^+ equilibrium price. The negative externality—i.e. one that causes damage to the third party—generates overproduction: we produce and use more electricity than what would maximize social benefits.

The impact of negative externalities on the market of a product



The bigger externalities linked to the market of a given product are, the greater the social loss resulting from misallocation. Externalities, however, may also be positive: in this case, the third party does not incur a loss but benefits from the effects not taken into account in the market. Environmental pollution is usually a negative externality.

That is why we mentioned in the introduction to this chapter that environmental pollution was not only harmful to nature and to nature-lovers but to everyone. Even if there may be people who are not annoyed by forests dying as a result of acid rains, everyone is affected by inefficient market allocation and the fact that, due to the misuse of resources, economic performance will be lower than its potential. The damage caused by the externality is randomly distributed among the members of society, generally reducing welfare.

Increasing pollution can lead to increasing damages, but reducing damage is costly. If we do not want to spend money on avoiding or reducing pollution, the damage caused by it may rocket. A totally pollution-free world can only be a theoretical idea because the costs of achieving zero emissions would probably be infinite. How much pollution is allowed, then?

As we have seen in the previous diagram, welfare loss is described as the difference between Q' and Q* (Q'-Q*) and not between 0 and Q* (0-Q*). This means that if environmental pollution is also taken into consideration, the optimal level of emissions will be Q', instead of zero.

Environmental economics and, particularly, its main branch based on welfare economics consider that the solution to the problem lies in **the optimal level of environmental pollution**.

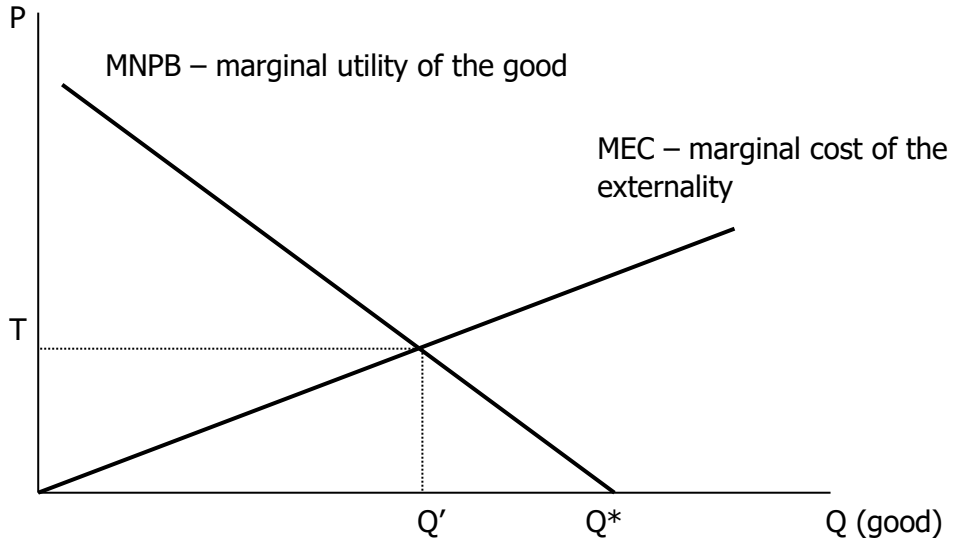
Setting aside the situation in which externalities are ignored, there are two ways to achieve lower environmental costs: either by reducing market equilibrium quantity from Q* to Q' (by generating and consuming less electricity), or by disconnecting the generated quantity and the pollutant emissions (i.e. generating the same amount of electricity with less sulfur dioxide emissions through a technological change).

In the next model, the MEC (marginal external cost) function will be used for measuring the damage caused by pollutants. This function measures the damage caused by sulfur dioxide emissions—in the form of acid rains—in the tree stock of the forest holding. If we want to achieve the optimal level of environmental pollution by reducing the produced quantity, its cost will be the lost profit of the output – if we sell less electricity, we will get less revenue (although our costs will also be lower), thus, altogether, what we will lose is our profit that could have been generated by the withheld quantity. The profit loss caused by decreasing economic activity is measured by the MNPB (marginal net private benefit) function. The independent variable of the functions (horizontal axis) is the physical size of the activity (Q), i.e. the quantity of the electricity that we produce and consume, while the dependent variable (vertical axis) is the economic value (P), i.e. the price in euros, for example.

Withholding the output (its initial level is Q*) is a good solution as long as the net benefit (MNPB) that we lose due to the reduction is less than the loss incurred by the third party (MEC). The production volume ensuring the efficient level of environmental pollution (Q') will be the produced quantity (Q)

where MNPB = MEC. Reducing the production further than Q' does not generate social benefit because, moving from Q1 towards 0, the values of MNPB are consistently higher than the values of MEC (this is true for all Qs between 0 and Q').

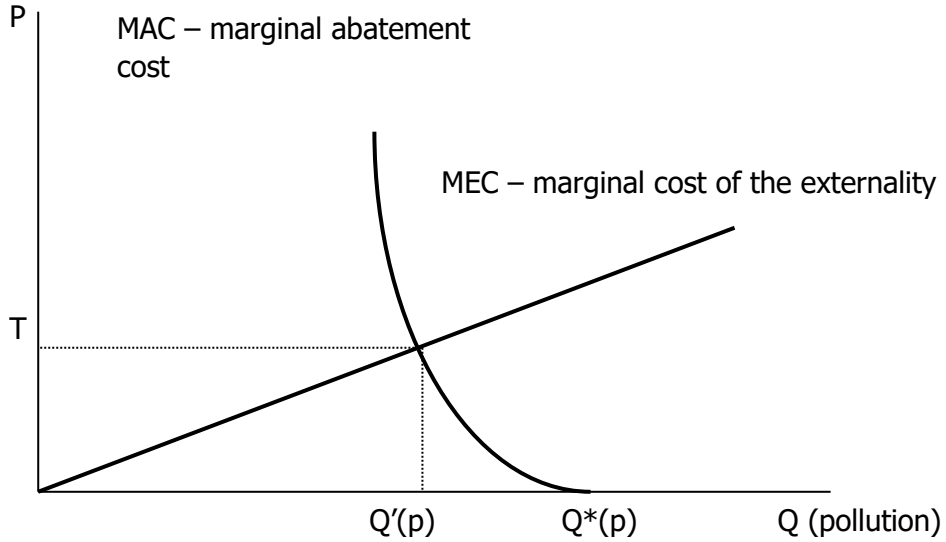
Attaining the efficient level of externalities by reducing production



Let us now examine the other option, where the market equilibrium quantity does not change, but the associated pollution is reduced by using an additional environmental technology (in the case of the power station, for example, by adding desulfurization equipment to the existing technology and purchasing coal with significantly lower sulfur content at a slightly higher price). Reducing pollutant emissions in this way, evidently, comes with a cost. In environmental economics, this is measured by the MAC (marginal abatement cost or, more generally, the marginal cost of the abatement of externalities) function.

It is advisable to reduce pollution from level Q* to Q', as long as the values of MAC are consistently below the values of MEC. The efficient level of pollution is defined by the equality MAC = MEC. Emissions below Q' are not efficient because the cost of attaining them is higher than the amount of damage that emissions would cause.

Attaining the efficient level of externalities by reducing pollution



Therefore, the optimal level of pollutant emissions is either the size of economic activity (Q [product]) where the marginal net private benefit (MNPB) of the activity is equal to its marginal environmental cost (MEC), or the level of pollution (Q [pollution]) where the marginal abatement cost (MAC) of the pollution is equal to its marginal environmental cost (MEC).

Although we know, in theory, where the socially efficient (optimal) level of pollution would be, it is not established automatically because of externalities. Therefore, government intervention is needed, which will set an additional rule forcing or encouraging polluters to take measures to approach the efficient level.

8.3. Environmental Policy Interventions

Although environmental interventions have a long history, they became widespread and generally used in the second half of the 20th century, in response to the environmental problem that became obvious in the 1960s. The explosion of environmental interventions is well evidenced by the fact that, within the EU acquis, the corpus of environmental legislation is one of the corpora with the largest number of legislative acts.

Environmental policy interventions are essentially based on two economic theories. One of them is the theory of A.C. Pigou, according to which the main reason for environmental problems is the fact that they constitute externalities; therefore, the solution is to eliminate (internalize) externalities.[217] Pigou's original idea was to impose a tax on pollution, more specifically, on the product causing pollution. The imposition of the tax solving the problem of externalities (Pigovian tax or *economic incentives*) requires that the government know (calculate) the efficient level of environmental use. If, however, the government knows what the efficient level of pollution is, it cannot only impose an incentivizing tax but also prescribe the efficient level of pollution by means of a kind of technological instruction (*command and control*).

Forty years after this theory had been published, R.H. Coase proposed a different solution.[218] What Coase realized is that the internalization proposed by Pigou entails considerable transaction costs: the government needs to collect data, explore the relationship between the producers' marginal utility (calculate the MNPB function), know exactly how much external cost (MEC) the different pollutions cause, and at what cost (MAC) these emissions can be reduced. According to Coase, if we let the efficient level be defined by way of an agreement between the polluters and the victims of pollution, that would require less calculation and data collection, since the parties concerned are aware of their own benefits and costs. Coase identified the problem of environmental pollution as the lack of a clear definition of pollution-related rights in the different legal systems. It is unclear whether it is polluters that have the possibility (right) to use the environment without restrictions or the victims that would have the right to an unpolluted environment. The solution proposed by Coase was that the state should define clear dispositive rights concerning environmental use, and then the parties concerned—aware of their rights and interests—would be able to reach an agreement on the efficient use of the environment if such coordination is not hindered by high transaction costs. The Coase theorem today is implemented in practice in the form of *allocation of rights* and *liability rules*.

[217] Pigou, A.C. (1920): The Economics of Welfare, Macmillan and Co., London

[218] Coase, R.H. (1960): 'The problem of social cost', The Journal of Law and Economics, vol. III, October 1960, pp. 1–44.

Possible ways of resolving market failures according to the theories of Pigou and Coase

	According to the Coase theorem		According to Pigou's theory
	By allocation of rights	By compensation	By command and control or Pigovian tax
Who should find the optimum?	The cooperation and agreement of polluters and victims	The court	Calculation by the government or municipality
What is the task of the government?	Facilitating the cooperation and agreement by creating an appropriate legal environment	Setting civil law rules in advance (legislation)	Calculation of the optimum, introduction of a corresponding regulatory tool and enforcement of compliance
What are the obstacles to such regulation?	If transaction costs cannot be reduced	If the institutional cost is too high (the court cannot obtain the information needed for decision-making)	If the optimum cannot be calculated or if the regulatory tool based on it is not efficient

Source: Bartus and Szalai, 2014, p. 129.

Today, environmental economics generally distinguishes four major types of environmental policy intervention based on the two above-mentioned theories:[219]

(1) **Allocation of rights: property (rights) and contracts.** Externalities or public goods, jointly used (free) goods, are generated by high transaction costs, but the magnitude of transaction costs depends on the legal systems. There are various ways of reducing them: Pareto-efficiency may emerge in accordance with the Coase theorem if we turn something into a property if we define who has the right to make decisions about something, or if we allow parties to bargain (we do not ban bargaining but even facilitate it by reducing transaction costs).

(2) **Liability rules, compensation**. Where transaction costs cannot be reduced, the legal system will be responsible for properly allocating decision rights—since the parties will not be able to transfer them to others—

[219] The list follows the description included in Bartus and Szalai, 2014.

and for protecting such rights. The latter is done by means of compensation, where the party violating the rights of others is obliged to pay compensation, with the aim of preventing the violation of the rights of others. This basic scheme of compensation is called *objective liability*. However, the so-called *fault liability* is often more important. It means that the party causing the damage does not necessarily have to pay, but only 'if it did not act as expected in the given situation'. When, in the case of a specific incident of damage, the court defines what it considers to be expected conduct, it practically establishes the same kinds of standards as those that appeared in the previous analysis as emission or pollution limit values.

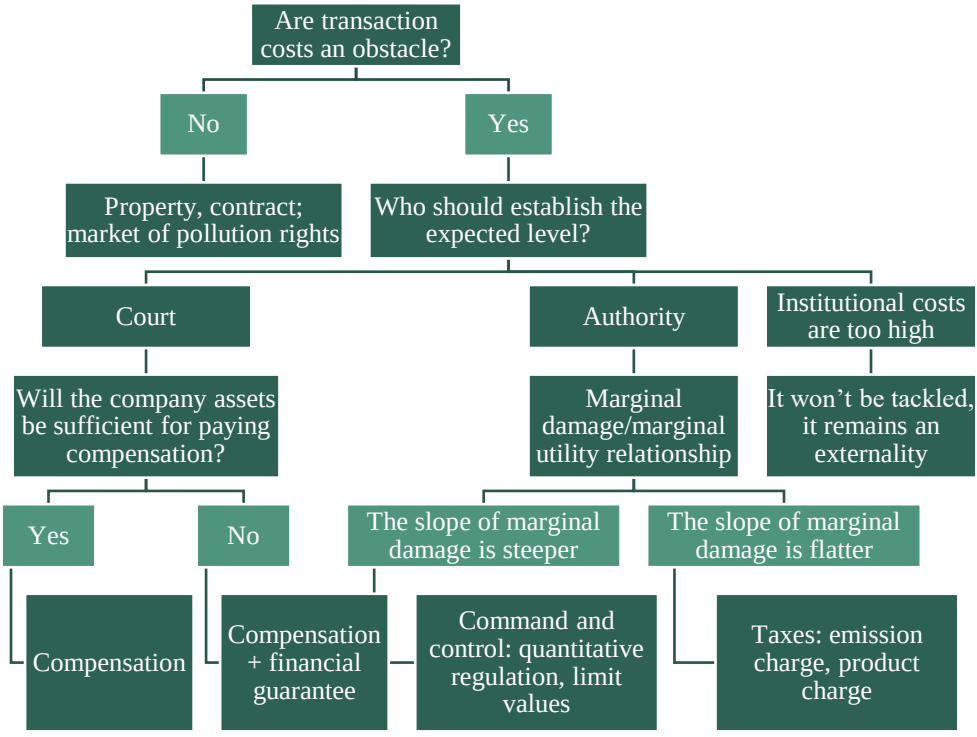
(3) **Command and control**. Command-and-control is a set of physical, technological and sometimes financial instructions in a legal form, which are binding on everyone. Command-and-control instructions lay down rules for the users of the environment concerning:
(a) the materials or procedures they are allowed or not allowed to use during production or consumption,
(b) their maximum permitted environmental load (actual pollutant emissions),
(c) the conditions (authorization, impact assessment, obligation to give a deposit or guarantee) that they must meet before commencing their activities.

(4) **Economic incentives**. Similarly to liability rules and compensation (objective liability), economic incentives are tools that are suitable for the 'pricing' of environmental use and for making the actors concerned directly face the costs of externalities. They include taxes, fees, contributions *(market-based instruments*). When economic incentives are applied, the regulator does not prohibit any action, nor does it oblige the users of the environment to do something, yet it makes users pay for the use of the environment in some way. Thus, environmental use is reflected in the costs of the producer or the consumer, which encourages the users of the environment to look for alternative solutions. As opposed to objective liability, however, this cost can be applied not subsequently, i.e. after the damage caused by environmental pollution occurred, but already in earlier phases of the pollution process (at other points of the pollution chain).

Although the adoption of environmental intervention is a logical consequence of the need to deal with market failures that become manifest in the

form of environmental pollution or the overexploitation of natural resources, it merits further consideration. Besides market failures, there are also *government failures*, where the action of the intervener increases social losses, because the cost of an inadequate intervention may be higher than the value of the externalities it eliminates (which is the benefit of the intervention). There may also be cases where it is not worth dealing with the external impact because there is no intervention that would have a positive benefit/cost relationship. Another important aspect is that the type of environmental policy instrument (intervention form) used for dealing with a recognized environmental problem makes much difference. The reason for this is that the costs and the benefits of the intervention (e.g. reduced pollution) depend on the type, scope and severity of the instrument selected (e.g. if the efficient instrument is a limit value, it must also be decided what that limit value should be).

The design of environmental policy interventions according to Bartus and Szalai



G. Bartus and Á. Szalai, Környezet, jog, közgazdaságtan [Environment, Law, Economics], Pázmány Press, Budapest, 2014.

The figure presents a simplified scheme that gives guidance on the aspects to be considered when choosing between different environmental policy instruments.

Conclusion

In this chapter, we have demonstrated that—concerning the inefficient use of the environment—environmental economics is in possession of theoretical knowledge and practical solutions to mitigate the adverse effects of externalities. The fact that the almost century-long history and results of the research on environmental policy interventions have not led to the effective and widespread adoption of such interventions is the consequence of the indifference and lack of courage of political communities. Therefore, the degradation and overexploitation of our natural resources is a reality, although we have the means to avoid it.

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Olivér Hortay

9. Behavioural Environmental Economics and Green Nudges

The assumption of perfect rationality, which is the solid basis of traditional economic thought, began to waver ever more in the second half of the 20th century. This was partly due to the large number of experimental results showing that rational behaviour can be used to describe the behaviour of economic operators only to a limited extent. The main problem lies in the irrational behaviour patterns that are systematic, i.e. generally characteristic of people. Over the last few decades, many researchers have argued that traditional economic models and policy tools should be adapted to these distortions. The purpose of this subchapter is to briefly describe the main behavioural anomalies that have a significant impact on the findings of traditional environmental economics and to introduce the so-called green nudge tools, which make use of distortions for environmental purposes.

9.1. Endowment Effect

It can be observed through experiments that, for people, the function of marginal utility of obtaining a given product is convex, while the function of negative marginal utility of giving up a product is concave, which means that the difficulty of giving up a product exceeds the happiness of obtaining it. This systemic asymmetrical behaviour pattern is known as the endowment effect. The most important consequence of this effect in terms of environmental economics is that, in the case of certain goods and under certain negotiation circumstances, the Coase deal does not lead to a Pareto efficient state[220].

9.2. Status Quo Effect

People tend to hold on to their established practices: in their decisions, there is a kind of inert conservatism, which is called status quo bias. Experience has shown that companies' preference for old, less efficient, but familiar technologies over new ones, even if the use of new technologies would pay off, constitutes a significant constraint on their decisions about investments

[220] D. Kahneman, J. L. Knetsch, R. H. Thaler, 'Anomalies: The Endowment Effect, Loss Aversion and Status-quo Bias', Journal of Economic Perspectives, vol. 5, no. 1, 1991, pp. 193–206.

increasing environmental performance. Most of the time, such bias is explained by loss aversion. Companies attach more weight to the potential risks of new technologies than to their future benefits, which hampers the expansion of solutions and, thus, the improvement of environmental performance[221].

9.3. Bandwagon Effect

In repeat experiments, it is often observed that there is an interplay between the participants' strategies; for example, the kindness of a participant is affected by the kindness of the others. Man is a social being; therefore, people are often willing to 'divert' their behaviour from what is rational in order to achieve more efficient inclusion in a given community. This distortion is called group effect or bandwagon effect. It is a new type of coordination mechanism in environmental policy since the drivers that move people to act are different: in public interventions, the driver is an external incentive, in market mechanisms, it is self-interest. In contrast, in the setting of a group effect, the main drivers are the norms of a given community. Separate waste collection is a good example of this phenomenon: in many countries, there are no consumer-level public incentives (there is no tax on traditionally collected waste, and no benefits are granted to those collecting their waste separately) or market incentives (separate waste collection requires an extra effort and does not generate any extra benefits), but the number of people participating in this system is increasing because they feel that such behaviour makes them more responsible members of the community.

9.4. Green Nudge

In addition to clarifying models that capture the impacts of 'hard' public interventions (regulations, taxes, subsidies), systematic behavioural distortions have also opened the way to a new 'soft' intervention, known as 'nudge'. The representatives of this trend suggest an incentive that does not limit the choice of actors but—taking advantage of the behavioural distortions described above—creates a decision-making context in which participants are more likely to select the option chosen by the regulator (or 'choice architect') over others. This kind of 'soft' policy approach is called 'libertarian paternalism', with reference to free choice and the patronizing leadership of the

[221] L. Venkatachalam (2005): Damage Assessment and Compensation to Farmers: Lessons from Verdict of Loss of Ecology Authority in Tamil Nadu, Economic and Political Weekly, vol. 40, 2005, pp. 1556–1560.

choice architect. The choice architecture includes the description of the options, the establishment of their structure and the creation of the context (or framing)[222]. Green nudge is different from the traditional nudge type of incentive. Both of them are interventions that are different from the preference of the person making a choice, but while the latter aims to increase the welfare of the choosing person, the first one promotes the welfare of the community. Of all the distortions described above, the majority of green nudge tools used in practice build on the bandwagon effect and the status quo bias. In the following sections, some practical examples will demonstrate how they are used.

9.4.1. Green Nudge Techniques Based on Group Effect

Over the last few decades, plenty of examples have shown that people can be greatly influenced by reminding them of certain social standards. In the 1980s, in Texas, a campaign called 'Don't Mess with Texas' was launched to reduce the quantity of waste thrown out of cars. The campaign's slogan was written on billboards alongside motorways. The witty reference became a great success: in a few years, the quantity of roadside waste was reduced to less than a third. The key to the success of the measure was strengthening group identity[223].

Another frequently cited example of the use of group norms is the Opower program launched in the US, which achieved an average reduction of household energy use of over two percent simply by indicating on consumers' household energy reports not only their own consumption but their neighbors' energy consumption as well[224]. Solutions based on group effect can often result in a status competition, which can be exploited by decision-makers. The driving force behind the early proliferation of electric vehicles and solar cells was that, by using them, owners could show their acquaintances that they were more responsible members of the community than others. This effect has enormous additional potential since any indication or symbol can

[222] R. Münscher, M. Vetter and T. Scheuerle (2016): A Review and Taxonomy of Choice Architecture Techniques, Behavioural Decision Making, vol. 29, no. 5, 2016, pp. 511–524.
[223] M. Nagatsu (2015): Social Nudges: Their Mechanisms and Justification, Review of Philosophy and Psychology, vol. 6, no. 3, 2015, pp. 481–494.
[224] H. Allcott (2011): Social Norms and Energy Conservation, Journal of Public Economics, vol. 95, no. 9, 2011, pp. 1082–1095.

be a good incentive through which users can show to their community that they are environmentally conscious[225].

9.4.2. Green Nudge Techniques Based on Status Quo

In addition to constituting a constraint when it comes to technological transition, status quo bias can also be used as a nudge-type incentive in cases where consumers have to make minor decisions. In such cases, people tend to choose the 'default' option. This may be an important tool for queries about social preferences, on the one hand, and may be used for incentivizing specific choices, on the other. For example, on the registration platform of an increasing number of scientific conferences, the cost of travel-related 'carbon offsetting' is included in the registration fee by default. Since this cost item is low compared to the total cost of participation, which is usually not borne by the applicants themselves, the relevance of choice is also low; therefore, few people choose another option.

9.4.3. Ethical Issues Associated with the Green Nudge

There may be several ethical concerns about nudge-type incentives. Firstly, while the objective of classic public interventions and the tools used to attain them can be easily monitored, in the case of a nudge, this is way more problematic. Secondly, these tools can reduce people's autonomy because if everyone knows that a choice design is optimized, individuals will be less motivated to seek information. Thirdly, as nudge is often easier than providing information, this can easily result in a negative trend whereby regulators increasingly turn to nudge tools even when informing the society would be the better option. Finally, the diffusion of nudge tools and the fact that such solutions build on instinctive behaviour patterns can reduce people's autonomy. Due to the ethical concerns related to the green nudge, in these cases the need for transparency is even more pronounced than in the case of traditional incentives: it is important to call people's attention to the fact that their choice has been designed with nudge tools, because, in this way, a large part of the ethical concerns can be resolved, since people identify with the objectives of their community and the program's efficiency will not decrease either.

[225] R. H. Thaler and C. R. Sunstein (2008): Nudge: Improving Decisions About Health, Wealth, and Happiness, New Haven & London, Yale University Press, 2008.

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Noémi Csigéné Nagypál

10. Corporate Social Responsibility and Sustainability

Corporate Social Responsibility (CSR) is an increasingly popular and well-known concept throughout the world. In this chapter, we will review the reasons for this, along with the importance of CSR; then, after a brief historical review and the explanation of related concepts, we will discuss relevant topical issues in this field, particularly the role of CSR in the European Union. For reasons of space, our objective is not to discuss the subject exhaustively but to give some basic ideas about this complex and increasingly topical issue.

10.1. The Importance of CSR

The responsibility of companies is justified by the fact that they **hold and control** a very **significant portion of** both natural and human **resources**. Furthermore, a considerable part of research, development, and innovation expenditure is incurred in the corporate sector, which also contributes to their important role in addressing sustainability.

Companies also play a key role in **individuals' quality of life**, both as employers, since we spend a large part of our productive life in our workplace, and as producers of products and services, since the range and quality of available products and services also have a significant impact on the quality of life. Over-consumption and other anomalies of the consumer society are also becoming ever more popular areas of discussion and research. Can the artificial generation of needs be regarded as responsible behaviour? Do companies always serve real consumer needs, or are there any 'unnecessary products', as Gergely Tóth calls them?[226] Consumer needs, of course, are constantly evolving, and the welcome rise in the standard of living as well as the free flow of information also leads to growing 'average consumer expectations'. (The movement of 'voluntary simplicity', which calls for the voluntary reduction of consumption on environmental and ethical grounds, can be seen as a counterweight to this.)

[226] G. Tóth (2007): A Valóban Felelős Vállalat (The Really Responsible Company), Környezettudatos Vállalatirányítási Egyesület,

While apart from ensuring their own welfare, contributing to the prosperity of future generations (children, grandchildren) also ranks high among an individual's objectives—sometimes it is even regarded as more important than their own personal interests—, many people think that today's 'frantic' development, paradoxically, jeopardizes the **possibilities of future generations**. While, traditionally, having more resources or having the possibility of consuming them used to reduce risks and increase the chances of prosperity and survival, this is not necessarily the case today. (A prosaic example is obesity and overweight, which constitute a disease of civilization that reduces the quality of life and the chances of survival of many people.)

The **responsibility of companies in addressing sustainability challenges** is an extremely **complex issue** for several reasons.

It is difficult to identify the role that companies can play in addressing the different challenges. (For example, in the fight against famine, food donations appear to be a logical step on the part of food companies. However, due to its negative effects on local farmers and food industry companies, for example, this is not always recommended.) Partly for this reason—i.e. the fact that companies do not necessarily know how to respond to environmental and social challenges—, **cooperation between businesses and non-governmental organisations** has become popular since the 2010s, in which companies cooperate with civil society organisations that are highly familiar with the nature of the environmental and social problem in question. (For relevant experience in Hungary, see e.g. Harangozó and Zilahy, 2015[227].)

The operation of companies is complex, and so are their internal processes as well as their impact on their operating environment, which are also difficult to measure and analyse. This is one of the reasons for the **great variety of approaches** to and interpretations of corporate responsibility and sustainability, as well as the **large number of tools** developed to improve corporate environmental and social performance.[228]

Companies are **diverse** in terms of size, sector, ownership, among others. Accordingly, considerable research is carried out into the sustainability or CSR efforts of companies operating in different sectors. Within a given **sector**, the areas and instruments of responsibility can be better defined. For

[227] Harangozó, G. and Gy. Zilahy (2015), 'Cooperation between business and non-governmental organisations to promote sustainable development', Journal of Cleaner Production, vol. 89, 2015, pp. 18–31.
[228] Kósi, K and L. Valkó (eds.) (2008): Környezetmenedzsment [Environmental Management], Typotex Kiadó, Budapest, 2008, p. 308.

example, the sector-specific guidelines of the Global Reporting Initiative (GRI), which analyses companies' sustainability reports, are useful tools for the companies of the sectors concerned. At the same time, cooperation within the sectors is often stigmatized and regarded as a concerted action of companies for the purpose of exerting pressure on regulators and also for 'softening regulation' in order to improve their own possibilities of operation. Another area, which is popular because of the diversity of companies, is the analysis of the corporate social responsibility or sustainability practices of **small and medium-sized enterprises** (SMEs)[229] [230], which is more similar in character to individual responsibility than the traditional social responsibility typical of large companies.

In relation to CSR, the issue of **consumer responsibility**—i.e. whether, in certain cases, consumers are able to make decisions beyond their own self-interest—also emerges. There is extensive literature on sustainable and responsible consumption[231] [232] as well. However, in a globalizing world, whose population is still growing and where the consumer base of traditional market products is dynamically expanding, it is unfortunately unlikely that environmentally conscious consumers in developed countries can achieve a significant change in production patterns. Furthermore, the 'gap' between the environmentally conscious approach and the truly conscious consumer behaviour (e.g. product choice) is also a popular area of research, with good reason. This is one of the reasons for which the responsibility of companies is beyond question, as it is unlikely that consumer expectations can make companies switch to sustainable operation and production on a large scale in the near future.

A large number of definitions of CSR include a reference to its **voluntary nature**. This is partly due to the fact that companies can be expected to take

[229] Málovics, Gy. (2011): A vállalati fenntarthatóság értelmezéséről [The Interpretation of Corporate Sustainability], JATEPress, 233.
[230] Csigéné Nagypál, N. (2014): Corporate social responsibility of Hungarian SMEs with good environmental practices, Journal For East European Management Studies, vol. 19, no. 3, 2014, pp. 327–347.
[231] Valkó L. (2003): Fenntartható/környezetbarát fogyasztás és a magyar lakosság környezeti tudata [Sustainable/Environmentally Friendly Consumption and the Environmental Awareness of the Hungarian Population], Working Paper, Budapest University of Economic Sciences and Public Administration, Institute of Environmental Science, Budapest, 2003, p. 55.
[232] Csigéné Nagypál, N. and G. Görög (2015): A társadalmilag felelős fogyasztás egyes jellemzőinek vizsgálata egyetemi hallgatók körében [Analysis of Certain Features of Socially Responsible Consumption among University Students]', Marketing és Menedzsment, vol. 49, no. 2, 2015, pp. 3–18.

a proactive approach, as they are most aware of their own capabilities and possibilities. Another reason for the importance of voluntary nature is that regulations are not always able to keep pace with technological or even social development processes. In addition, regulations are not everywhere equally stringent; for example, companies operating in several countries and locations around the world can be expected to follow the best practice even in an environment where the requirements of environmental protection or work safety are less stringent and sophisticated. However, voluntary practices entail the risk of focusing on areas that fit in well with a company's scope of activities or offer market advantages, instead of the most important sustainability issues. In the case of corporate social responsibility, voluntary nature **brings benefits** in several respects, but companies must be aware of the **risks** that it entails and try to reduce them.

Is it a problem if a company's **responsibility is motivated by self-interest**? Probably, it is not a problem; in fact, in this case, the company's real commitment is less questionable. Nevertheless, the truth about companies is revealed in the market. This is what Milton Friedman expressed with the following and still often quoted sentence in the 1970s: 'the business of business is business'.[233] A sad example demonstrating that responsible operation does not necessarily contribute to long-term success is Nokia, which had won several CSR awards in Hungary, but in the end, it was forced to reduce its production capacity and relocate it to Asia gradually. (In this respect, CSR awards are like fair play awards or prizes for the best-dressed competitors at sporting events, where the real result is still the best possible ranking.)

Companies are able to maintain their operation in the long run; they often 'survive' different systems. (It is disputable, of course, whether a company can be considered to be the same company after changes in its scope of activities, ownership structure or places of business.) It is undeniable, however, that the decades-long history and, frequently, the charismatic and creative personality of the founder(s) are integral parts of the identity of many large companies. Often, the objective of the founding engineer or inventor is to solve a current problem or improve people's quality of life with a product that is innovative at that moment. From this perspective, long-standing or even recently founded innovative companies have more competences and possibilities to address sustainability challenges than leaders at different levels, elected for short periods of time.

[233] Friedman, M. (1970): The Social Responsibility of Business Is to Increase Its Profits", New York Times Magazine, 13 September 1970.

In addition to approaches focusing on the responsibility of 'conventional companies', new trends that **redefine the basic corporate objectives** have also emerged. The main goal of 'entrepreneurs with a different objective' or 'social enterprises' is not to generate profits but to address a social or a combined social and environmental problem. The concept of social enterprise has become so widely accepted in the European Union that, in 2011, the European Commission issued a communication entitled 'Social Business Initiative. Creating a favourable climate for social enterprises, key stakeholders in the social economy and innovation'[234]. The concept of really responsible companies, created by Gergely Tóth, can also be mentioned here: it means that a really responsible company aspires to achieve fairness (e.g. fair trade and working conditions), reduce transport distances and the associated environmental externalities, and to achieve an optimal size, instead of becoming as large as possible. For such a company, profitability is important but is not the main objective. Furthermore, it pursues activities or manufactures products that are actually needed and whose 'existence is justified in a sustainable world'[235]. Unfortunately, in the context of today's complex supply networks and products, these requirements are extremely difficult to measure and to meet. The concept of 'sustainable business models'[236] is also a promising new approach.

Nevertheless, the responsibility of companies following the traditional model remains an important issue. The next section gives a brief summary of **the history of CSR and the related concepts**.

10.2. A Brief History of CSR

A large number of researchers[237] refer to the American **Howard Bowen's** book entitled 'Social Responsibilities of the Businessman'[238], published in 1953, as the first significant work on the responsibility of companies and business leaders. The issue, i.e. the role of companies in the society, was not completely new, of course. There had always been companies and business leaders that, besides market position and profitability, had also taken into

[234] European Commission, Social Business Initiative. Creating a suitable climate for social enterprises, key stakeholders in the social economy and innovation, SEC(2011) 1278 final, 2011.
[235] Tóth, op.cit., p. 66.
[236] Zilahy, Gy. (2016): Sustainable Business Models – What Do Management Theories Say?, Vezetéstudomány – Budapest Management Review, vol. 47, no. 10, 2016, pp. 62–72.
[237] Loew, T., K. Ankele, S. Braun and J. Clausen (2004): Significance of the CSR Debate for Sustainability and the Requirements for Companies, Berlin, Münster
[238] Bowen, H. (1953): Social Responsibilities of the Businessman, Harper and Row, New York, 1953, p. 276.

account other roles of the company. These include measures implemented at the end of the 19th century and the beginning of the 20th century to improve the living conditions of workers, or corporate donations[239], among others.

The **stakeholder theory** and stakeholder management, which began to gain ground in the 1980s, are also closely related to the scope of CSR. This is also confirmed by the European Commission's definition of CSR as 'a concept whereby companies integrate **social and environmental** concerns in their **business operations** and in their interaction with their **stakeholders on a voluntary basis**'[240].

The essence of the stakeholder approach is that companies (or, in a broader sense, any entity) should take into consideration not only the interests of their owners, such as shareholders but also the interests of and the effects on all the parties that are affected by the objectives, operation and impacts of the company. According to the most widely accepted definition, 'stakeholder is any **group or individual** who can affect or is affected by the **achievement of the organisation's objectives**'[241].

These stakeholders can be grouped on the basis of different criteria, for example, whether they are **market** or non-market stakeholders, **external** or **internal** actors. Regarding the grouping of stakeholders, Csigéné and Pálvölgyi[242] introduced the concepts of quasi-internal and potential stakeholders, besides conventional internal and external stakeholders. **'Quasi-internal stakeholders'** are those actors that are more affected by the operation of the company than external stakeholders and have more influence on corporate processes, but in a strict sense, they are not considered to be internal stakeholders. They may be suppliers in a close relationship with the company (e.g. service providers performing tasks that used to be internal processes but were later outsourced) or investors that have not become owners, yet constantly monitor the company's operation. These may include the operators entrusted by the company with facilitating its operation in certain areas. Consultancy firms—which are important actors in the area of social responsibility and corporate sustainability—have more insight into the operation of a company than external stakeholders, they need to better identify with the company's target system and can propose certain improvements as 'insiders'.

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[239] Tóth, op.cit., 2007.

[240] European Commission, Promoting a European framework for corporate social responsibility, Green Paper, COM (2001) 366, 2001, p. 8.

[241] Freeman, R.E. (1984): Strategic Management: A Stakeholder Approach, Pitman, 276.

[242] Szlávik J. (ed.) (2009): A vállalatok társadalmi felelősségvállalása [Corporate Social Responsibility], Complex Kiadó, 291.

Therefore, they share the features of internal stakeholders in some respects, but the effectiveness of their activities also comes from the fact that being outsiders, they have a different view of the company's operations than the management. They also introduced the concept of **'potential stakeholders'**, i.e. stakeholders that are ignored by a number of companies and are difficult to manage. This group includes the natural environment—which is not considered by all companies as a stakeholder, or whose interests are taken into account through the mediation of other stakeholders, e.g. NGOs, regulators—as well as 'future generations', which have a key role to play in the approach of sustainable development.

One of the reasons why the stakeholder concept has become widespread and popular in business circles is probably the fact that, as part of their management activities, business leaders can deal with general, abstract social problems to a limited extent, since the expectations of stakeholders are more practical and manageable[243]. As early as the 1990s, Clarkson concluded that **companies, in practice, deal with the expectations of stakeholders** rather than with social expectations[244]; therefore, a distinction must be made between the demands of stakeholders and social issues. For this reason, **external stakeholders also have a major responsibility** in better communication of social needs to the company and in ensuring that they focus on the most important problems.

Each stakeholder is affected by the activity of the company to a different extent, and vice versa, i.e. they can influence the company's operations differently. **The power/interest grid** illustrates the differences between groups.[245] Freeman and Velamuri[246] suggested that corporate social responsibility should henceforth be called **'corporate stakeholder responsibility'**, since—in their opinion—that would provide a more precise expression of the direction and real content of responsible corporate behaviour. With regard to stakeholders, it is important to note that stakeholder groups are not neces-

[243] Knox S. and S. Maklan (2004): Corporate Social Responsibility: Moving Beyond Investment Towards Measuring Outcomes, European Management Journal, vol. 22, no. 5, 2004, pp. 508–516.
[244] Clarkson M.B.E. (1995): A Stakeholder Framework for Analysing and Evaluating Corporate Social Performance, Academy of Management Review, vol. 20, no. 1, 1995, pp. 92–117.
[245] Johnson K., K. Scholes and R. Whittington (2008): Exploring Corporate Strategy (8th Edition), 8th Edition, Prentice Hall, 664.
[246] Freeman R.E. and R. Velamuri (2006): A New Approach to CSR: Company Stakeholder Responsibility', in A. Kakabadse and M. Morsing (eds.), Corporate Social Responsibility (CSR): Reconciling Aspirations with Application, Basingstoke Palgrave Macmillan, 2006, pp. 9–23.

sarily homogeneous and the interest and power relations may change continuously, thus, it is worth re-identifying the stakeholders of a company from time to time.

A concept related to CSR is CSP, which stands for **corporate social performance**: it dates back to the 1970s and aims to identify societal needs and the possible responses in order to strengthen the social legitimacy of companies.[247] [248] [249] Initially, CSP models were considered to be equivalent to CSR in the relevant literature; however, from the 1990s, the emphasis of CSP has shifted towards the measurement of the performance of responsible activities. The CSP approach aims to encourage companies to become familiar with the social needs and expectations related to their activities and to address them proactively[250]. Such demands are also expressed by stakeholders, which means that this approach is closely related to the stakeholder theory.

The first researchers focusing on the concept of **'corporate conscience'** were Goodpaster and Matthews in the early 1980s[251]. They consider that the extension of the concept of a person assuming social responsibility to legal persons will lead to the ideal of a responsible company. They interpret responsibility in the context of decision-making, i.e. the consequences of decisions on others must also be taken into consideration.

Within corporate social responsibility, the so-called **corporate citizenship** (CC) approach initially regarded companies as 'good citizens', which are active in society[252] and voluntarily carry out some socially positive philanthropic activity. From the 1990s, globalization has given a great boost to the expansion and development of this theory, thus, the corporate citizenship approach, which **initially** focused only on **local communities**, has acquired an

[247] R.W. Ackermann (1973): How Companies Respond to Social Demands, Harvard University Review, vol. 51, no. 4, 1973, pp. 88–98.
[248] S.P. Sethi (1975): Dimensions of Corporate Social Performance: An Analytical Framework, California Management Review, vol. 17, no. 3, 1975, pp. 58–64.
[249] A.B. Carroll (1979): A Three-Dimensional Conceptual Model of Corporate Performance, Academy of Management Review, vol. 4, no. 4, 1979, pp. 497–505.
[250] D. Bank (2017): Implicit és explicit, valamint belső és külső CSR egy kettős függésben lévő piacgazdaságban, különös tekintettel a munkavállalókról való gondoskodásra [Implicit and Explicit, Internal and External CSR in a Double Dependent Market Economy. Especially Regarding Labor Provisions], PhD thesis, Corvinus University of Budapest
[251] K.E. Goodpaster and J.B. Matthews (1982): Can a Corporation Have a Conscience?, Harvard Business Review, January – February 1982.
[252] A.B. Carroll (2008): A History of Corporate Social Responsibility. Concepts and Practices, in A. Crane et al. (eds.), The Oxford Handbook of Corporate Social Responsibility, Oxford University Press, Oxford, 2008, pp. 19–46.

international orientation and interpretation. At the 2002 World Economic Forum, representatives of 46 multinational companies signed the statement entitled 'Global Corporate Citizenship: The Leadership Challenge for CEOs and Boards'[253]. In that document, business leaders declared that they would endeavor to do business in a manner that obeys the laws, produces safe and cost-effective products, creates jobs and wealth, and reflects international value-based standards, integrating all this into core business strategy. They underlined that the relationships with stakeholders were fundamental to the internal and external success of companies, that business leaders played a key role in making the company a good citizen, and that assuming such personal responsibility was essential for the company's long-term success.

Since the 2000s, a large number of authors have sought to clarify the discourse on corporate citizenship and to identify different approaches. According to Matten et al.[254]**, the corporate citizenship theory includes three approaches**:

- a limited view, which focuses only on the companies' philanthropic activities;
- an equivalent view, which is most commonly associated with CSR and suggests that companies should assume responsibility for a better quality of life of the members of society;
- an extended view, according to which corporate citizenship becomes active when the government fails to protect the interests of citizens.

The last view clearly demonstrates that the concept goes beyond the discussion of the role of companies and can be interpreted in a broader context.

Carroll's pyramid model[255] is one of the best known and most cited concepts of corporate responsibility. The essence of the model is that there are different levels of responsibility, which basically build upon each other. The lowest level is **'economic responsibility'**, which is the absolute basis and a decisive factor in the company's current and continuous future operation; therefore, it is a fundamental requirement set by the owners. The second level is **'legal responsibility'**, which refers to compliance with the regulations, thus representing the fundamental, formally expressed and widely accepted

[253] WEF (2002): Global Corporate Citizenship: The Leadership Challenge for CEOs and Boards, World Economic Forum, Geneva

[254] D. Matten, A. Crane and W. Chappel (2003): Behind the Mask: Revealing the True Face of Corporate Citizenship', Journal of Business Ethics, vol. 45, no. 1-2, 2003, pp. 109–120.

[255] A.B. Carroll (1991): The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organisational Stakeholders, Business Horizons, July–August 1991, pp. 39–48.

expectations of society in this respect. As current regulations are unable to cover all the expectations that are important from an ethical perspective, the next level is **'ethical responsibility'**, i.e. the fulfillment of requirements that are not codified into legal regulations, yet are fundamental from an ethical point of view. Finally, the highest level is **'philanthropic responsibility'**, which means the fulfillment of the higher than average expectations of certain groups, instead of the expectations of the society as a whole. The model, which was popular in the early 1990s, has been used, analysed or reconsidered by many. Some have pointed out that in certain countries, due to weak regulation and enforcement, philanthropic responsibility comes before legal responsibility[256]. Csigéné[257] suggests that there is an additional level of responsibility, which could be called orientational responsibility. It means that companies can direct their customers and consumers, and shape their expectations, for example, towards sustainable consumption.

Matten and Moon[258] introduced the concepts of **implicit and explicit CSR**, analysing and comparing the conditions and corporate practices of CSR in Europe and the United States. The starting point for their analysis is that, in the United States, explicit reference to CSR is more frequent in corporate communication than in Europe. The reason for this is that in Europe, due to the high level of environmental and work safety standards, companies have less responsibility beyond regulatory compliance. Explicit CSR activities are understood as deliberate, voluntary activities, which tend to stem from the company's strategy, while implicit CSR means compliance with regulatory requirements.

Corporate sustainability has also been defined and interpreted in various ways since the 1990s. The International Institute for Sustainable Development, Deloitte & Touche and the World Business Council for Sustainable Development (WBCSD) defines sustainable development for companies as follows: 'adopting business strategies and activities that meet the needs of

[256] W. Visser (2008): Corporate Social Responsibility in Developing Countries, in The Oxford Handbook of Corporate Social Responsibility, Oxford University Press (eds: A. Crane, A. McWilliams, D. Matten, J. Moon and D.S. Siegel), 2008, pp. 473–499.
[257] N. Csigéné Nagypál (2018): What is beyond philanthropic responsibility?, in The 7th International Conference on Social Responsibility, Ethics, and Sustainable Business, ASE Publishing, 2018, p. 20.
[258] D. Matten and J. Moon (2008): "Implicit" and "Explicit" CSR: A Conceptual Framework for a Comparative Understanding of Corporate Social Responsibility, Academy of Management Review, vol. 33, no. 2, 2008.

the enterprise and its stakeholders today, while protecting, sustaining and enhancing the human and natural resources that will be needed in the future'[259]. According to Málovics[260], corporate sustainability is a paradoxical concept, since, **in principle, the concept of sustainability cannot be** interpreted **at a corporate level.** According to Csigéné[261], corporate social responsibility starts at the micro-level, from one of the causes of problems, while the sustainability approach looks for solutions starting from macro-problems (effect). The advantage of the concept of corporate responsibility is that the responsible subject, i.e. the company, is clearly identified, while in the case of sustainability, the task of each actor is difficult to define in the pursuit of 'one major common goal'. For more information on the role of CSR in achieving strong sustainability, see the article by Málovics, Csigéné and Kraus[262].

A relatively new concept, which has given new impetus and direction to the discourse on corporate social responsibility, is **creating shared value** (CSV)[263]. The main idea is that companies can create value not only for their owners but also for all stakeholders, for example, by meeting societal needs.

We have already discussed in detail the importance of taking into consideration the interests of stakeholders. As the role of external stakeholders increases, logically, **external communication** also **becomes more important**. A key tool in this process is the publication of reports under different names (e.g. sustainability report, CSR report) in order to present the evolution of the company's social and environmental performance.

The **Global Reporting Initiative** (GRI) is an initiative that was launched in 1997 as a result of the cooperation between CERES (Coalition for Environmentally Responsible Economies) and UNEP (United Nations Environmental Programme). In 2001, it became a separate institution, independent of CERES, and has been active ever since. In 2000, GRI issued its first guideline entitled 'Sustainable Reporting Guidelines', on the basis of which ap-

[259] C. Labuschagne and A.C. Brent (2005): Sustainable Project Life Cycle Management: the Need to Integrate Life Cycles in the Manufacturing Sector, International Journal of Project Management, vol. 23, no. 2, 2005, pp. 159–168, p. 160.
[260] Málovics, op.cit., 2011.
[261] N. Csigéné Nagypál (2008): A vállalatok társadalmi felelősségvállalása és kapcsolódása a fenntarthatósághoz [Corporate Social Responsibility and its Relationship with Sustainability], Doctoral thesis, Budapest University of Technology and Economics, 2008.
[262] Gy. Málovics, N. Csigéné Nagypál and S. Kraus (2008): The Role of Corporate Social Responsibility in Strong Sustainability, Journal of Socio-Economics, vol. 37, no. 3, 2008, pp. 907–918.
[263] M.E. Porter and M.R. Kramer (2011): Creating Shared Value, Harvard Business Review, vol. 89, no. 1-2, 2011, pp. 62–77.

proximately fifty sustainability reports were published. The number of corporate reports drawn up worldwide using the GRI's guidelines has exceeded 10,000. As a result of a constant relationship with stakeholders and the development of corporate practice, the content of the guidelines is updated continuously. This process is well demonstrated by the fact that G3.1 contained 79, while G4 some 150 suggested indicators. Furthermore, additional sector-specific guidance documents have also been elaborated for some sectors, which are significant in terms of their environmental and social impacts, with the involvement of business actors representing the sectors in question. Under GRI 4, such sectors included the electricity sector, business services, mining and metal processing, the NGO sector, as well as the oil and gas industry. As of 19 October 2016, G4 guidelines have been replaced by the **GRI Standards**.

In 2010, the International Organisation for Standardization issued a standard called **ISO 26000, Guidance on social responsibility**. Unlike the standards for quality management systems (ISO 9001) and environmental management systems (ISO 14001), the CSR standard does not include the possibility of certification for organisations. Nevertheless, a large number of companies—of different sizes and activities—around the world regard this standard as a point of reference, thus, it is worth outlining its content in brief. The standard contains the key concepts and principles of CSR, as follows:

- accountability: the organisation must be accountable for its impacts,
- transparency: the organisation's decisions and activities must be transparent if they affect the environment and society,
- ethical behaviour: behaviour based on the values of honesty, fairness and integrity,
- respect for stakeholder interests,
- respect for the rule of law,
- respect for international norms of behaviour,
- respect for human rights, recognition of their importance and universal nature.

It aims to support the integration of responsibility into the company's **target system and processes** as well. It covers the areas of CSR (human rights, labour practices, environment, fair operating practices, consumer issues, community involvement and development), the importance and methods of stakeholder identification, as well as communication. The importance of the

standard lies in the fact that it **gives a comprehensive overview of the interpretation of CSR**, although some experts consider it to be too **general** and permissive.

10.3. CSR in the European Union

Corporate social responsibility has already become a **widespread and widely accepted concept in the European Union** as well. It was in the 1990s that this concept started to gain ground within the EU and became the subject of substantive technical discourse. In the historical background, a major step was the appeal that **Jacques Delors**, then President of the European Commission, made in 1993 to businesses in Europe, asking them to get involved in the **efforts for social cohesion** and eventually to assume social responsibility. In 1995, the predecessor of the non-profit organisation 'CSR Europe' was established. CSR Europe—which has members in the EU Member States (including Hungary) and in some other European countries—still plays an important role in promoting corporate social responsibility, in the exchange of experience, in providing a professional forum, organising conferences, and awarding companies that deliver outstanding performance (European CSR Award).

In 2000, the European Commission published a **green paper** entitled 'Promoting a European framework for corporate social responsibility', which contains the EU's position and principles concerning CSR. The document describes the 'internal', 'external' and practical dimensions of corporate social responsibility with the aim of presenting all that CSR encompasses. The internal dimension includes human resources management (e.g. ensuring equal opportunities in terms of selection and employment to all workers, including people at a disadvantage; training; supporting lifelong learning), health and safety at work, adaptation to change, the management of environmental impacts and natural resources, as well as resource use and the reduction of waste. The external dimension includes the relations with local communities as well as business partners, suppliers and customers, respect for human rights and involvement in the solution of global environmental problems. The practical dimension includes the tools associated with corporate management activities (codes of conduct, management systems, green accounting). Tools affecting consumers are labels (e.g. eco-labels), while socially responsible investment (SRI) is a tool affecting investors. The European Multi-Stakeholder Forum on Corporate Social Responsibility was established, offering an opportunity for stakeholders to hold a continuous dialogue.

In 2002, the European Commission's first **communication about CSR** was published, the title of which also reflects the typical approach to corporate social responsibility in that period: 'Communication from the European Commission concerning Corporate Social Responsibility: A business contribution to Sustainable Development'. The Communication states that some form of standardization is needed emphasizes the European Union's efforts to promote the social responsibility of small and medium-sized enterprises and underlines that CSR should be integrated into different policies.

The RARE project—a project funded by the Sixth Framework Programme of the EU in the field of R+D, in which the Department of Environmental Economics of the Budapest University of Technology and Economics was also involved (2004–2007)—included a comprehensive analysis of European corporate social responsibility practices. In order to compare rhetoric and reality, the international research group analysed some selected sectors: the extractive industry was represented by the oil sector, the manufacturing industry by the fish processing sector, and the services sector by the banking industry. Furthermore, a separate part was dedicated to the specificities of the responsibility of SMEs and the impact of EU enlargement on companies' CSR activity.[264]

In 2006, a new communication on **'making Europe a pole of excellence** on corporate social responsibility' was published[265]. It is enough to see the title to grasp the ambitious approach of the communication, which is in line with the Lisbon objective (making Europe 'the most competitive [...] knowledge-based economy in the world'). It implies a major change of approach, which was criticized by some NGOs: while the first communication considered CSR to be primarily an important tool for achieving sustainability, the new document focuses on its role in increasing competitiveness and employment. In addition to emphasizing the primary role of companies, it also highlights that NGOs can also play an important role in ensuring the effectiveness of CSR. The communication explains that CSR can also contribute to sustainable economic development and the achievement of the objectives of the European Growth and Jobs Strategy. It also addresses the need for raising

[264] R. Barth and F. Wolff (eds.) (2009): Corporate Social Responsibility in Europe: Rhetoric and Realities, Edward Elgar, 384.

[265] European Commission, Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee – Implementing the Partnership for Growth and Jobs: Making Europe a Pole of Excellence on Corporate Social Responsibility, COM(2006) 136 final, 2006.

awareness of CSR as well as the importance of the dissemination and promotion of best practices, the cooperation between Member States, consumer information, research and education. It underlines the need to strengthen the social responsibility of SMEs further and to address the international dimension of CSR[266].

In March 2006, the **European Alliance for Corporate Social Responsibility** was established by the European Commission. In this context, Günter Verheugen, then Commission Vice-President responsible for enterprise and industry policy, said: 'Europe needs a public climate in which entrepreneurs are appreciated not just for making good profits but also for making a fair contribution to addressing societal challenges".[267]

Shortly afterward, the European Parliament adopted its 'resolution of 13 March 2007 on corporate social responsibility: a new partnership' (2006/2133) on the proposal of British MEP Richard Howitt. **The Howitt report** emphasizes that an EU-wide CSR regulation should take into consideration the significant differences between Member States (European Parliament, 2007). It is promising that the resolution points out that 'CSR should tackle new areas such as lifelong learning, the organisation of work, equal opportunities, social inclusion, sustainable development and ethics'[268], because by doing so, it has connected CSR to a number of important social policy objectives.

At the beginning of the **renewed EU strategy** 2011–14 for Corporate Social Responsibility, it is stated that CSR is now in the interests of enterprises, since it reduces risks, facilitates access to capital, increases stakeholders' confidence, and it is also in the interests of society as a whole, as it can contribute to the priorities of the Europe 2020 strategy for smart, sustainable and inclusive growth. The document provides an evaluation of the impacts of the previous EU policy, indicating a number of positive results, e.g. a significant increase in the number of European companies using EMAS (Eco-Management and Audit) (from 3,300 in 2006 to 4,600 in 2011) or publishing sustainability reports according to the guidelines of GRI (from 270 in 2006 to 850 in 2011) or the number of companies that have signed up to the ten principles of the Global Compact (from 600 in 2006 to over 1900 in 2011). (However,

[266] J. Szlávik (ed.) (2009): A vállalatok társadalmi felelősségvállalása [Corporate Social Responsibility], Complex Kiadó, 291.
[267] http://europa.eu/rapid/press-release_IP-06-358_en.htm (3/11/2019)
[268] European Parliament, European Parliament resolution of 13 March 2007 on corporate social responsibility: a new partnership, 2006/2133(INI), 2007.

it is unclear to what extent this is due to the EU's CSR policy and to other global processes.)

The renewed strategy also provides a new definition, which is very general and comprehensive, as it defines CSR as **'the responsibility of enterprises for their impacts on society'**. In relation to the theoretical concepts described above, we can conclude that the document reflects the approach of strategic CSR and also relies on the concept of creating shared value (CSV), since it says the following: 'To fully meet their corporate social responsibility, enterprises should have in place a process to integrate social, environmental, ethical, human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders, with the aim of – maximizing the creation of shared value for their owners/shareholders and for their other stakeholders and society at large; – identifying, preventing and mitigating their possible adverse impacts.'[269]

The EU's CSR policy, therefore, also seeks to integrate the latest scientific findings, trends and theories. Since the 2000s, it has constituted an important policy area, which covers a number of domains affecting the management of the companies' internal and external stakeholders. It is seen as an important tool to **support the EU's strategic objectives**.

10.4. Conclusion

The concept of corporate social responsibility can be best imagined as a massive tree with lots of intertwining branch roots stemming from the main root at different depths and several small or large branches growing out of its trunk. One of the key purposes of this chapter was to **clarify these concepts**.

As CSR encourages responsibility beyond mere compliance with regulations, it can favour **the spreading of an innovative approach** in the corporate strategies and the companies' day-to-day operations. It can encourage and support proactive corporate behaviour that can contribute to the success and competitiveness of companies in the long term as well. There is extensive literature on the possible drivers of CSR and its **role in competitiveness**. Such connection is becoming increasingly apparent; according to the survey carried out by KPMG in 2013, for example, around one-third of the world's

[269] European Commission, A renewed EU strategy 2011–14 for Corporate Social Responsibility, COM(2011) 681 final, 2011, 7.

largest companies gain economic benefits from their CSR activities, mainly in the form of additional profits or the acquisition of larger market shares[270].

It is very positive that companies follow with attention and adopt the latest CSR trends, at least at the level of rhetoric. At the same time, it is important to avoid the phenomenon known as 'greenwashing' in the corporate environmental policies, which, in this case, could be called 'responsible appearance'. Many people are likely to encounter mainly the **most visible** and communicable forms and **manifestations** of corporate responsibility, such as donation or cause marketing. We hope that this chapter has made it clear that there is much more to it. CSR is more of a way in which companies try to find their place in the management of current complex problems concerning sustainability. We trust that this brief summary of the relevant trends and scientific findings will also help future corporate experts and business leaders succeed in this field.

[270] KPMG, The KPMG Survey of Corporate Responsibility Reporting 2013, KPMG International, Amsterdam, 2013.

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III. Green financing methods

Gábor Gyura

11. Green regulatory approaches

Since credit and equity markets provide economies' lifeblood, the financing conditions available for environmentally favourable or detrimental investments will ultimately significantly determine how sustainable these economies can be. However, similarly to non-financial firms, financial institutions are unlikely to take into account long-term sustainability considerations in their lending and investment decisions to a socially optimal extent without regulatory intervention. We, therefore, analyse how financial regulation is currently dealing with environmental aspects and how innovative regulatory approaches can further help the re-allocation of capital.

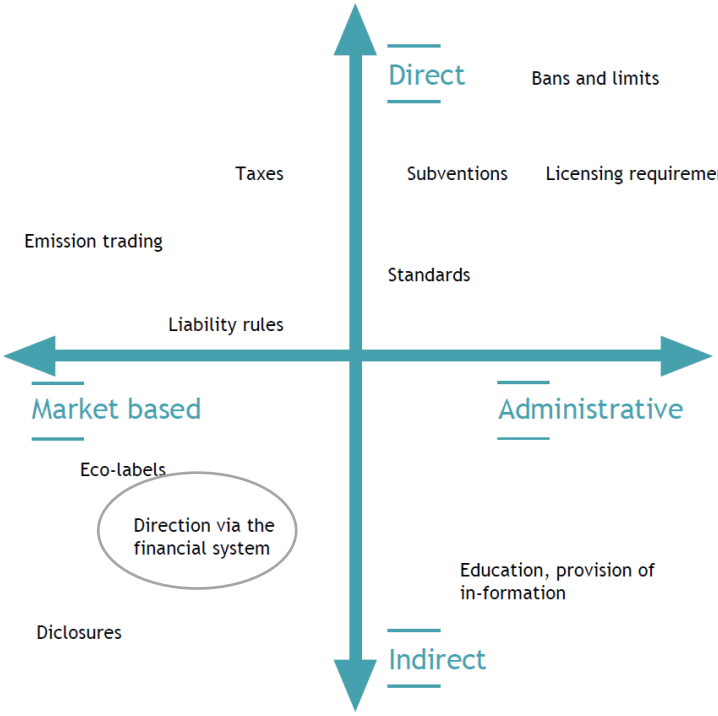
11.1. Why and what to regulate?

This chapter only focuses on financial regulation, but it is important to note that financial regulation can only supplement environmental regulation but can no means substitute it. Environmental, social policy can ensure via a range of possible measures (e.g. taxation, subsidies, bans and pollution limits) that actors of the real economy (i.e. industrial, agricultural firms, service providers etc.) operate in line with environmental or social sustainability expectations. In contrast, financial regulation can only ensure that banks and other financial institutions provide funding or financial risk management services to the actors of the real economy in a way that supports sustainability.

It is a relatively new recognition that "earthly" topics such as climate change cannot be dealt with independently of the financial, monetary sphere. Unsurprisingly, the recognition is partly coming from the realization of financing needs of sustainable development goals and, in particular, the investments required for climate change mitigation and adaptation. This has received increasing attention in the past decade, with more and more studies covering the topic.[271]

[271] See for instance:
UNCTAD (2014). World Investment Report 2014. Investing in SDGs. Geneva
Clark et. al. (2018): Bridging funding gaps for climate and sustainable development: Pitfalls, progress and potential of private finance. Land Use Policy 71 (2018) 335–346.
European Commission (2019): The European Green Deal. Brussels, 11.12.2019, COM(2019) 640 final. Available at: https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf. Retrieved 16 December 2019.

Range of possible environmental regulation approaches



Source: Gyura (2019).

While the estimations vary in some of the details, they all point to the fact that public funds are unsatisfactory to meet those financing needs, especially taking into account the already high indebtedness of governments. In other words, the mobilization of private funds is essential, i.e. banks, investment funds and other financial institutions need to step-up the financing of environmentally beneficial projects, and – at the same time – scale down the funding of those activities that are environmentally unsustainable, like fossil fuel-based power generation.

Environmentally unsustainable activities are also likely to have higher financial risks in the longer term. The so-called transition risk stems from the fact that stricter environmental policies, rapid technological changes, or changing customer preferences could render these activities unprofitable, thereby also impairing loans and equities financing them. Another unique risk related to environmental sustainability is the physical risks of climate change. Extreme

weather events and acute problems caused by climate change are also drivers of credit risk, and possibly also market and liquidity risks[272].

Both the financing needs of sustainable development goals and the financial risks driven by environmental factors may call for regulatory intervention. In the latter case, the goal of regulation is to maintain financial stability: by nudging financial institutions to identify, assess and manage environmental driven financial risks, regulation can simultaneously support financial soundness and, at the same time, increase the volume of green financing – as detailed below.

However, why exactly is there a case for regulation? One might argue that banks and other financial institutions are rational, profit-maximizing entities with very sophisticated risk management, modeling and business planning functions. What could be the main reasons why they do not incorporate environmental sustainability considerations in their strategies adequately?

There are many possible reasons, out of which the two main important ones are externalities and short-termism. Banks finance firms and economic activities predominantly on a risk-adjusted return basis. Even if, in some cases some other factors (e.g. reputational gains) also come into play, the deciding factor determining what kind of financing conditions environmentally sustainable projects receive, is mainly based on the profitability of the potential loan. The income generation capacity of the borrower is, in turn, primarily determined by the respective economic conditions. Without the externalities properly internalized, the sustainability of various economic activities is unlikely to pay off. In fact, being "green" often costs more (due to costs related to waste management, pollution monitoring and control etc.) and therefore reduces profitability.

Many studies have, for instance, highlighted the lack of internalization of fossil fuel's externalities. Irena (2016) estimated that the reduction of pollution and climate impact through increased use of renewable energy by 2030 could save up to USD 4.2 trillion per year worldwide[273]. The external costs

[272] NGFS (2019): A call for action. Climate change as a source of financial risk. Available at: https://www.ngfs.net/sites/default/files/medias/documents/synthese_ngfs-2019_-_17042019_0.pdf. Retrieved: 2020.02.27.

[273] Irena (2016): The True Cost Of Fossil Fuels: Saving On The Externalities Of Air Pollution And Climate Change. Available at: https://www.irena.org/publications/2016/May/The-True-Cost-of-Fossil-Fuels-Saving-on-the-Externalities-of-Air-Pollution-and-Climate-Change. Retreved: 2020.02.28.

include pollution and environmental degradation resulting from the extraction of resources; indoor and outdoor air pollution due directly to fuel combustion as well as non-combustion emissions such as those from industrial processes; and the negative impact of extreme weather events caused by global warming. Nevertheless, these externalities are only partly built into fossil fuel generation's costs.

Besides the lack of the internalization of externalities, the other main reason why regulation is needed is the time horizon of financial institutions. As EBA put it in its report: "*it may be questioned if the current financial and strategic planning horizons of EU banks are sufficiently tailored to the integration of long-term challenges, such as those linked to the transition to a sustainable economy"*[274]. According to this study, the time horizon used by European banks for defining the business model and setting their strategy is in most cases about 3-5 years. This is obviously way shorter than the time horizon of large-scale environmental anomalies such as climate change. This problem was famously raised the first time by then-Governor of the Bank of England Mark Carney, like the Tragedy of Horizons, arguing that the impacts of climate change will be felt beyond the horizons of those actions now. In other words, the current generation is imposing a cost on future generations, and thus the current generation has a little direct incentive to fix[275].

Having said that, the next logical question is asking why banks fail to apply a longer term orientation in their strategy setting and business planning. EBA's report, as mentioned earlier,[276] outlines the following possible reasons:

- profitability pressures and shareholders' interest;
- accounting rules requirements unduly penalize long-term investments – at least as argued by banks;

[274] EBA (2019): Report on Undue Short-Term Pressure from The Financial Sector On Corporations, p. 20. Available at: https://eba.europa.eu/file/461440/download?token=gM-ur7b2. Retrived 28 February 2020

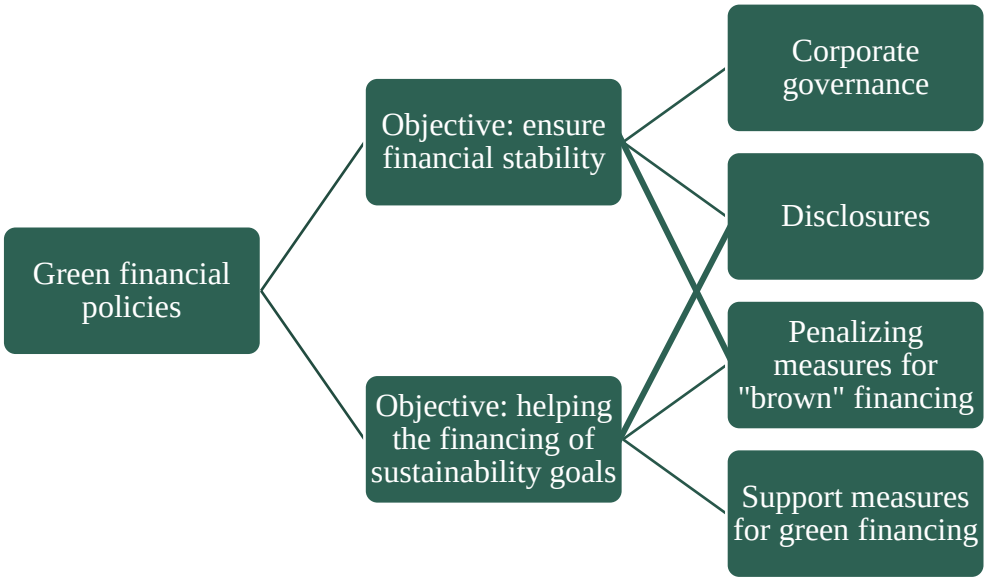
[275] Carney, Mark (2016): Breaking the tragedy of the horizon - climate change and financial stability. Available at: https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability. Retrieved: 2020.03.01

[276] EBA (2019): Report on Undue Short-Term Pressure from The Financial Sector On Corporations. Available at: https://eba.europa.eu/file/461440/download?token=gM-ur7b2. Retrived 28 February 2020

- macroeconomic factors might also play a role, for example, uncertainties about macroeconomic trends over a more extended period and the effect of monetary policies in the current period.[277]

To summarize, financial institutions might insufficiently take into account sustainability considerations because they have insufficient incentives for that (in the lack of internalization of externalities), and because sustainability problems are likely to materialize into more tangible problems only in the longer term.

Overview of the logic of key green financial regulatory approaches



Source: Author's own illustration

Obviously, there are many ways that regulation can affect financial institutions and capital flows. Some regulations are already in place, some are in a relatively mature stage of development, and others are still in a very preliminary phase of discussions, but may become part of the regulatory toolkit in the future. One possible categorization of the various regulatory approaches is according to their primary goal: whether they mainly aim at maintaining financial stability or at helping the financing of sustainability goals. The four

[277] EBA's study also highlighs that in a continuing low interest rate environment, a certain degree of pressure is put on institutions to restrict maturity transformation (difficulties in pricing long-term loans, for example).

most important elements within this kind of framework are corporate governance, disclosures and capital requirements (targeting either green or brown exposures).

11.2. Key elements of sustainable finance regulations

11.2.1. Corporate governance measures

The most logical measure in sustainable finance regulation is to enhance corporate governance so as to make financial institutions incorporate environmental considerations into their business. In the EU, several supervisory authorities have already issued such recommendations. In 2019 the Bank of England published its supervisory statement titled "Enhancing banks' and insurers' approaches to managing the financial risks from climate change"[278]. The statement "*describes the two risk factors through which financial risks from climate change arise and the distinctive elements which, when considered together, present unique challenges and require a strategic approach*", namely, physical and transition risks. As for this strategic approach, the Bank of England expects the following:

- embed the consideration of the financial risks from climate change in governance arrangements;
- incorporate the financial risks from climate change into existing financial risk management practice;
- use (long term) scenario analysis to inform strategy setting and risk assessment and identification; and
- develop an approach to the disclosure on the financial risks from climate change[279].

In Germany, the supervisory authority, Bafin, also issued its guidance, with a somewhat broader scope (sustainability risks in general), but with similar contents. [280] The *"Guidance Notice on Dealing with Sustainability Risks"*

[278] https://www.bankofengland.co.uk/prudential-regulation/publication/2019/enhancing-banks-and-insurers-approaches-to-managing-the-financial-risks-from-climate-change-ss

[279] Bank of England (2019): Supervisory Statement - SS3/19 Enhancing banks' and insurers' approaches to managing the financial risks from climate change., p.4. Available at: https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/supervisory-statement/2019/ss319.pdf?la=en&hash=7BA9824BAC5FB313F42C00889D4E3A6104881C44. Retrieved: 2020.03.01.

[280] https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Meldung/2019/meldung_191220_MB_Nachhaltigkeitsrisiken_en.html

provides a detailed description of recommended risk identification, management and control processes related to sustainability risk. It also covers stress tests and scenario analyses on an entity-specific basis.

Many other authorities plan to issue similar recommendations and guidelines. Similar approaches are expected EU-wide, as part of the EU Sustainable Finance Action plan (see below). The first such step is the European Banking Authority's Loan Origination Guidelines, which will – among other things – also set out expectations as to how environmental considerations need to be embedded in lending policies. Accordingly, the new guidelines (to be enter into force in 2021) will require that institutions should include environmental, social and governance (ESG) factors as well as risks and opportunities related to ESG in their risk management policies, credit risk policies and procedures (European Banking Authority 2019).

11.2.2. Disclosures

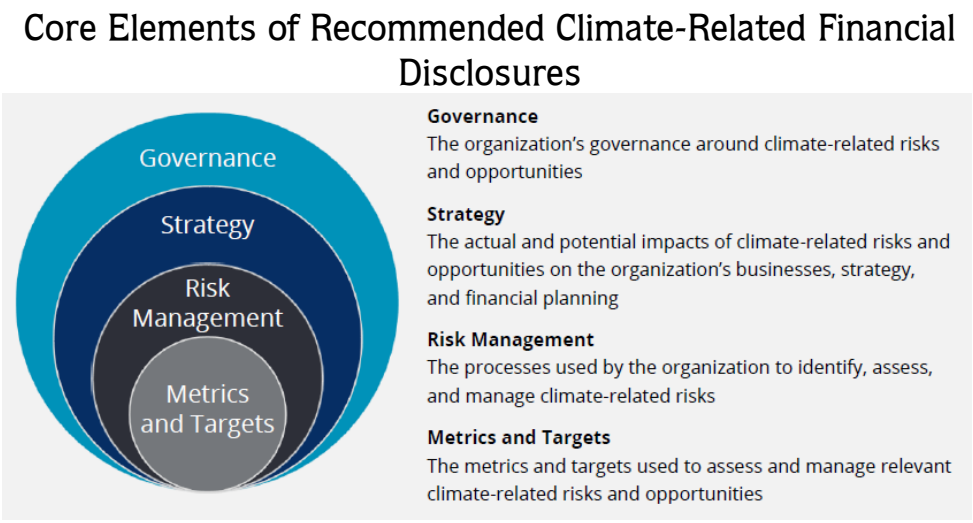
Disclosures have been an integral part of financial regulation for several decades now. For public securities, disclosures are key elements to enable informed investor decisions, and also for prudential regulation, for instance, in the Basel Capital Regulation's Pillar III approach[281], transparency is required so as to facilitate, that capital flows efficiently to the best risk/return targets. Taking into account the increasing awareness of how climate change and other environmental anomalies drive financial risks (NGFS 2018[282]), it has become a logical step to integrate climate risks into disclosure rules as well.

Disclosures are needed for two reasons and from two kinds of entities. First, firms that are borrowers or receiving equity investments need to disclose climate-related exposures so that banks and asset managers have information about the risks they entail when lending or investing in such companies. Such information also allows the financial institutions themselves to disclose how exposed they are to climate risks. Transparency is required not only about the exposures themselves (e.g. stock of loans to fossil fuel-based companies), but also about qualitative aspects such as policies and risk management procedures about climate risks.

This is the underlying principle of the Financial Stability Board's relevant recommendations. This standard-setting body published in 2017, through its special task force, the so-called TCFD-recommendations on Climate-related

[281] Basel Committee on Banking Supervision (2018): Pillar 3 disclosure requirements – updated framework. Available at: https://www.bis.org/bcbs/publ/d455.pdf. Retrieved 20 March 2020.
[282] NGFS (2018): A call for action.

Financial Disclosures (TCFD 2017). The recommendations cover four thematic areas that represent core elements of how organisations operate: governance, strategy, risk management, and metrics and targets. There are recommended disclosures for each of these with information that will help investors and others understand how reporting organisations assess climate-related risks and opportunities.



Source: TCFD (2017, p. v.)

The TCFD recommendations are non-binding, and, since they were formulated on the global level, logically somewhat general. They are, however, also forming the basis for many jurisdictions' similar initiatives. For instance, in the EU, the European Commission has issued guidelines on climate-related disclosures, that closely follow TCFD's policy (European Commission 2019).

11.2.3. Penalizing measures for brown lending

Many have also argued to use capital requirements to promote sustainable finance. There are two possible ways to do so: one can penalize exposures to "brown" (unsustainable) activities, or, alternatively set favourable capital requirements to green loans and investments.

The first approach is more widely supported by supervisors and regulators, as it is easier to integrate into existing prudential regulation and also easier to justify from a financial stability perspective. The underlying principle of the latter is that the riskier an asset is, the higher its capital requirements should be. It can be argued, that there might be firms and activities whose

climate- or environmental driven financial risks have not yet been properly identified and quantified, and therefore their riskiness is not adequately mirrored in capital requirements. Banks are of course sensitive to capital requirements, as equity is costly. If they need to hold more capital for a certain type of loans, they are likely to scale down such financing, and redesign their lending strategies.

The most logical choice for such assets are those exposed to transition risks. Any carbon-intensive industries and activities can depreciate in the long term due to higher carbon prices, carbon taxes or simply because becoming obsolete due to technological change or new consumer preferences. This kind of differentiation can be used in virtually all segments of the economy. For instance, the Dutch supervisor announced that it would look into the possibility of applying higher capital requirements to loans financing outdated, non-energy efficient properties. The latter, of course, consume more energy for heating and air-conditioning (indirectly also contributing heavier to greenhouse gas emissions), and therefore more exposed to rising energy prices and climate change mitigation policies, in other words, transition risk.[283]

11.2.4. Support measures for green financing

The other alternative is of course to reward loans and investments financing green economic activities. The argument is straightforward: by lowering the capital requirements of such exposures selectively, regulators can reduce the cost of capital for such financing, and make more of the loan decisions profitable. With lower capital requirements, banks can also lower the interest rates of green loans (thereby pushing more possible green investments to a positive net present value range), or simply earn more profit on these loans (which in turn would motivate banks to increase the supply of such lending).

So far the only central bank in Europe introducing a favourable capital requirement treatment for green loans is the Central Bank of Hungary (MNB). Since 2020, banks can make use of lower capital requirements for green mortgages and unsecured loans financing energy efficiency renovations in residential properties. A green mortgage is defined as an energy-efficient one (in line with the EU Taxonomy, see below), with a near-zero energy consumption. The basic idea is that energy-efficient properties come with lower utility bills, which in turn leave a higher disposable income with the borrower, a factor that can result in lower probabilities of default (PD). Energy-

[283] De Nederlandsche Bank (2017): Waterproof? An exploration of climate-related risks for the Dutch financial sector. Available at: https://www.dnb.nl/en/binaries/Waterproof_tcm47-363851.pdf. Retrieved 20 March 2020.

efficient properties might also have a more stable collateral value, which helps the so-called loss given default (LGD) component of credit risk. The combination of better PDs and LGDs can justify lower capital requirements, although MNB considers that the aforementioned "green hypothesis" still needs to be underpinned by research, and therefore the capital requirement discount is only available for a 4 year temporary period at this stage. It should be noted however, that existing research appears to support the green hypothesis, although these studies used fairly small samples.[284]

Other countries also analyse the option to introduce similar measures. China is one of them, and some studies already modelled the possible benefits of the approach. As Ma Jun (2018) put it, *"according to preliminary estimations, if the risk weight for green loans was reduced from the current 100% to 50%, it could reduce the financing costs by about 50 basis points (0.5 percentage points) for all green projects funded by green loans. Given the fact that bank loans are the primary source of funding for green projects in China, this measure could lower the financing costs of all green projects by 0.4-0.5 percentage points in the country. In addition, the "saving" of capital requirement for banks with substantial green asset exposure could allow these banks to extend more green credit".* Such a favourable treatment could be justified by the strong track record of green assets: as of June 2017, the non-performing loan ratio (NPL) of green loans was only 0.37%, far lower than the NPL ratio of 1.74% for the entire loan portfolio at 21 major banks. Statistics from 2013-2016 also showed similar patterns[285].

These four regulatory approaches (corporate governance enhancements, disclosures, brown and green exposure capital requirement adjustments) do by no means provide an exhaustive list of possible measures in sustainable finance – yet they are probably the most important ones today. There are many other ways financial regulations can help sustainability, some of which will be touched upon below, in the description of the frameworks in selected jurisdictions.

[284] see MNB (2019): Green Retail Lending in Hungary. Available at: greenfinance.hu. Retrieved 3 March 2020.

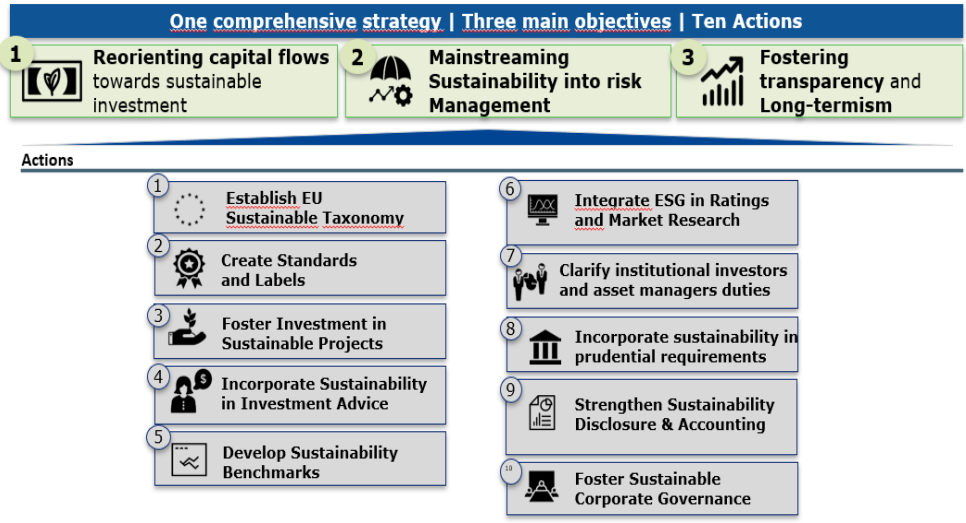
[285] Ma Jun (2018): China Should Lower Risk Weights for Green Assets. Available at: http://www.gflp.org.cn/index/index/newsdetail/id/22.html. Retrieved: 19 March 2020.

11.3. Selected international examples

11.3.1. European Union

In Europe, many financial institutions have come up with green financial products in the 2010s in the most developed financial markets (France, Netherlands, Nordic countries and the UK). This was largely an organic, bottom-up development, based on the recognition that customers are increasingly concerned about sustainability. As the market grew and deepened, market players themselves started to pursue self-regulation: trade associations began to develop standards for green finance. Joining forces with other (non-european) stakeholders, the International Capital Market Association's Green Bond Principles of 2014[286] was a major milestone to reach common ground about the green financial segment's fastest-growing asset class, green bonds.

Overview of the EU's Sustainable Finance Action Plan



Source: European Commission (2018).

Similarly, the Loan Market Association (in cooperation with partners) developed the Green Loan Principles[287], with a view to at least partly harmonizing green corporate lending. But this market-led self-regulation was not considered adequate by EU policymakers, which led to a comprehensive regulatory

[286] See www.icmagroup.org
[287] See www.lma.eu.com/documents-guidelines/documents/category/green--sustainable-finance#

initiative from the European Commission. The EU approach, as outlined below, still very much relies on market forces, compared to China (to be discussed in the subsequent subchapter).

Climate change and environmental sustainability has been a high priority item on the European Union's agenda since the early 2000s. At the same time, having a Single Market for financial services, based on a common set of rules, has also been a key element of EU policy. Therefore, it was a logical policy step to combine sustainability and financial regulation in a comprehensive strategy. The European Commission published the so called Sustainable Finance Action Plan in 2018, comprising three goals and ten actions.

This Action Plan has the objectives, to (i) reorient capital flows towards sustainable investment in order to achieve sustainable and inclusive growth; (ii) manage financial risks stemming from climate change, resource depletion, environmental degradation and social issues; and (iii) foster transparency and long-termism in financial and economic activity.

For the purpose of these three objectives the Action Plan builds on ten specific actions, many of which have already been analysed in this chapter. The overarching principle of the Action plan is to decrease the information asymmetries associated with sustainable finance. Accordingly, many actions target transparency and disclosures, be them firm-level or product-level. The main idea is to allow investors, consumers and also creditors to make informed decisions in a way that they understand how the financial product or financing to be provided contributes to sustainability.

In addition to disclosures, the most important element is the definition for sustainable economic activities, the so called taxonomy. As the Commission put it, a *"unified EU classification system - or taxonomy - will provide clarity on which activities can be considered 'sustainable'. It is at this stage the most important and urgent action of this Action Plan. Clear guidance on activities qualifying as contributing to climate change mitigation and adaptation, environmental and social objectives will help inform investors. It will provide detailed information on the relevant sectors and activities, based on screening criteria, thresholds and metrics. This is an essential step in supporting*

the flow of capital into sustainable sectors in need of financing. An EU taxonomy will be gradually integrated into EU legislation to provide more legal certainty."[288].

But how would this taxonomy work? A regulatory proposal was published in 2018, which was adopted at the end of 2019[289]. An economic activity shall be environmentally sustainable where that activity complies with all of the following criteria:

- it contributes substantially to one or more of the environmental objectives set out in the regulation;
- economic activity does not significantly harm any of the environmental objectives set out in the regulation;
- carried out in compliance with the minimum legal safeguards;
- and complies with technical screening criteria.

This taxonomy regulation defines six environmental objectives areas based on which economic activities should be assessed to judge whether it qualifies as environmentally sustainable:

(1) climate change mitigation;
(2) climate change adaptation;
(3) sustainable use and protection of water and marine resources;
(4) transition to a circular economy, waste prevention and recycling;
(5) pollution prevention and control;
(6) protection of healthy ecosystems.

In line with the Action Plan, a technical expert group was formulated, that published its comprehensive report in 2019, the so-called technical screening criteria, as mentioned above. This expert report, therefore, contains the quantitative and qualitative criteria to be used to decide what economic activities

[288] European Commission (2018): Action Plan: Financing Sustainable Growth, p.4. Available at: https://ec.europa.eu/transparency/regdoc/rep/1/2018/EN/COM-2018-97-F1-EN-MAIN-PART-1.PDF. Retrived: 2 March 2020.
[289] Council of the European Union (2019): Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the establishment of a framework to facilitate sustainable investment - Approval of the final compromise text. 2018/0178 (COD)

should be regarded as contributing to climate change mitigation or adaptation.[290] This taxonomy is the very heart of sustainable finance, as any regulatory measures by Member States or the EU itself, or by financial institutions, will need to be aligned with the taxonomy.

To wrap up, the EU sustainable finance regulation consists of a comprehensive set of measures. The package's most important element is clearly the taxonomy (from this perspective, the EU regulation is relatively stringent), but otherwise the EU still applies a somewhat light-touch approach: the other key ingredient, disclosures, rely by definition very much on market forces.

11.3.2. The Chinese model: green credit policy and other measures

China has one of the fastest-growing green finance markets. By early 2020, China has reached some notable achievements, including, but not limited to:

- the stock of outstanding green loans increased to over 10 trillion yuan ($1.4 trillion);
- 900 billion yuan of green bonds has been issued since 2016 (making China one of the largest green bond markets);
- at least 400 green private equity funds were launched[291].

The country became one of the frontrunners of green finance by using a unique regulatory way, which is remarkably different from other major economies' approach. The Chinese model is based on a top-down, state directed mechanism. While the evolution is partly market-driven, but regulation has a much more important role than in the EU or in the US. China heavily regulates the key elements:

- it has developed three sets of national green taxonomies and dozens of green finance product guidelines and standards;
- introduced many innovative policy incentives for green finance (e.g. the central bank's green relending facility and local government interest subsidies for green loans); and

[290] Technical Expert Group (2019): Taxonomy Techncal Report. Available at: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-taxonomy_en.pdf

[291] Ma Jun (2020): Five insights into China's green finance transformation. Available at: https://www.centralbanking.com/central-banks/financial-stability/4399401/five-insights-into-chinas-green-finance-transformation. Retrieved 19 March 2020.

- announced a road map for compulsory environmental disclosure standards for listed companies[292].

The Chinese approach is based on a recognition that market failures are prevalent in environmental and financial issues. Market forces themselves will not result in optimal outcomes in green finance: without proper regulations in place, banks will inadequately take into account environmental aspects in their lending operations, green financial products will not necessarily pursue real environmental impacts, nor will green investments enjoy sufficiently beneficial financing conditions.

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[292] Ma Jun (2020): Five insights into China's green finance transformation. Available at: https://www.centralbanking.com/central-banks/financial-stability/4399401/five-insights-into-chinas-green-finance-transformation. Retrieved 19 March 2020.

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- Ma Jun (2018): China Should Lower Risk Weights for Green Assets. Available at: http://www.gflp.org.cn/index/index/newsdetail/id/22.html. Retrieved: 19 March 2020.
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12. Green Central Banking

12.1. Introduction – Central banks mandates and climate change

Traditionally, central banks' mandates embrace three closely intertwined areas with a significant emphasis on the first one: price stability (inflation), economic growth and financial stability. Different central banks have different pre-set goal functions that emanate from the given central bank law conveyed by a political body (for example democratically elected parliament) depending on the political system of the given monetary block. This act provides the framework in which central banks are operating independently and set the monetary policy in order to fulfil the goals as mentioned above. It should be stressed that within that framework, central banks have considerable room to define policies in an idiosyncratic, in theory, "technocratic" way.

This modus operandi simultaneously yields some flexibility and the legitimacy to make decisions pertinent to the socioeconomic structure. This field is in no way of a static one, therefore in the last several decades, a distinct evolution has been observable triggered by the rapidly changing environment (like globalisation, new technologies etc.) that should be addressed by central banks. Along this way central banks have been paying constant attention to avoid the situation where the objectives could be severely compromised but changing functional roles throughout history, alternating between price stability, financial stability and support of the State's financing in times of crises have been observable.[293]

It is of utmost importance to recognise that central banking is much more an art than a science meaning that monetary policy cannot be algorithmized blindly: new challenges require new instruments.

However, many commentators consider central banks' measures addressing climate change as a grey area because it could endanger central banks' abilities to fulfil their original mandate and move into the realm of political policy. This development could be rather controversial according

[293] Goodhart, Charles A.E. (2010): The Changing Role of Central Banks." SSRN Electronic Journal.

to the critics because central bankers are not elected by the public; therefore, they are not authorised to implement all of the public economic policies (like allocation and redistribution)[294] per se, only to act strictly according to a well-specified mandate to stabilise the economy.

In the following several pages we would like to outline the counterargument and to point out that climate change – and on a broader sense many other environmental issues like loss of biodiversity etc. – pose significant risks to central banks traditional objectives, hence climate change risk could fit entirely into the monetary framework with only some caveats. Consequently, for central banks, it is not only an option but a necessity to internalise climate-related uncertainty, which could be a source of significant systemic risk in the long run.

Besides that, paving the way for the smooth transition from the age of fossil energy to the age of sustainable model is also crucial in order to avoid supply-side price shocks and the risk of becoming "climate rescuers of last resort" (to backstop asset price drop and panic, central bank could be forced to buy up the liabilities of the fossil-based industry).

Eventually, lack of any reaction in the present could threaten central bank independence in the long term due to the potentially sudden and unexpected disastrous effects of climate change that would force the central bank to act without any room to manoeuvre.[295]

To summarise with the words of NGFS' (Network for Greening the Financial System) First Progress Report (2018): "*NGFS Members acknowledge that climate-related risks are a source of financial risk. It is therefore within the mandates of Central Banks and Supervisors to ensure the financial system is resilient to these risks. As set out in the academic literature, climate change will affect the global economy and so the financial system that supports it. The financial risks it presents are in consequence system-wide and potentially irreversible if not addressed. Exact pathways may be uncertain but it is foreseeable that financial risks will crystallise in some form through either the physical or transition channel, or some combination of them both. And*

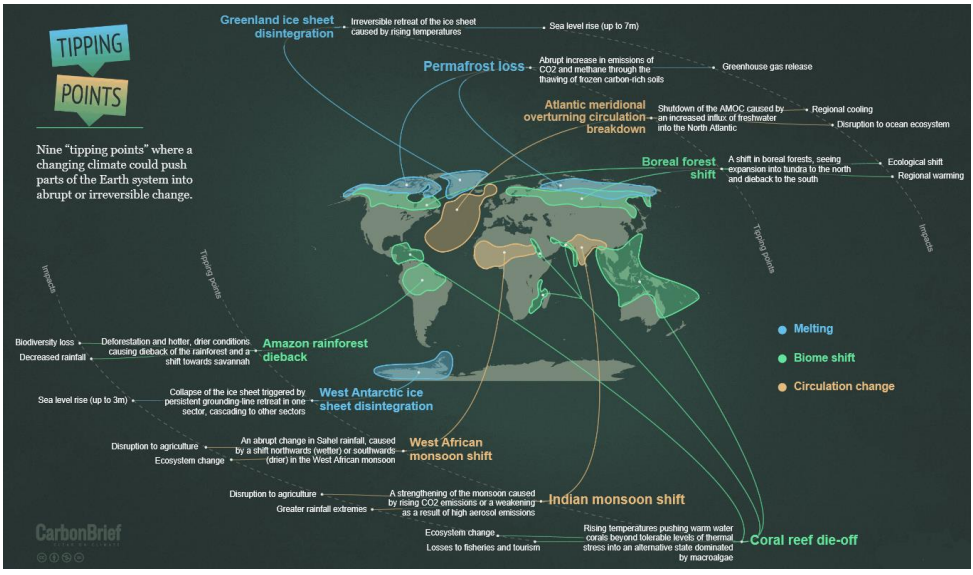
[294] Brunnermeier, Markus K - Jean-Pierre Landau (2020): Central banks and climate change. https://voxeu.org/article/central-banks-and-climate-change

[295] Honohan, Patrick (2019): Should Monetary Policy Take Inequality and Climate Change into Account? in Peterson Institute for International Economics. Working Paper 18-19.

while the financial risks may be realised in full over the extended time horizon, the risks call for action in the short-term to reduce impact in the long-term."[296]

12.2. Monetary policy and macroeconomic effects of climate change and climate policies: uncertainties and channels of risks

First of all, it is important to stress that climate models inherently imply a lot of uncertainties and controversies revolve around the accuracy of these models.[297] Nevertheless, facing this situation does not mean that polluting or altering our environment does not put us in uncharted territory with potentially significant consequences. Precautionary principle – our climate is a complex system with many nonlinear tipping points that could destabilise the climate significantly – dictates actions aiming the build down of CO_2 emission even without accepting the scientific consensus related to the climate change.



Source: https://www.carbonbrief.org/explainer-nine-tipping-points-that-could-be-triggered-by-climate-change

[296] A sustainable and responsible investment guide for central banks' portfolio management, Networking for Greening the Financial System, Technical document - https://www.ngfs.net/sites/default/files/medias/documents/ngfs-a-sustainable-and-responsible-investment-guide.pdf
[297] https://www.fooledbyrandomness.com/climateletter.pdf

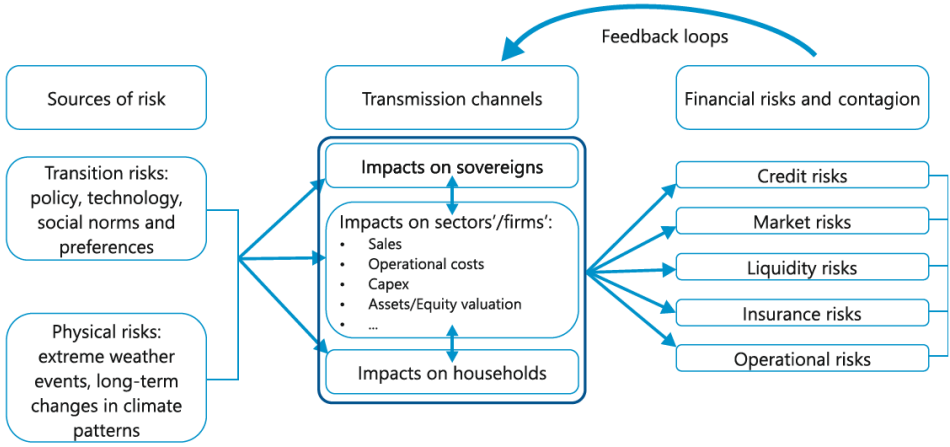
For sure, it does not mean that climate scenarios reinforced by many of the well-respected scientists are not plausible sufficiently but strongly underpins the necessity of adjustment even with considerable uncertainties in these models. The table below shows the potential tipping points of our climate that could lead us to an irreversible plight.

Moreover, the factors as mentioned above are only the direct potential causes of climate change and do not regard the multiple nonlinear dynamics in the society, economy, technology etc. that interact with each other in a complex way that makes almost impossible to predict the future. Therefore, the traditional way of calculating the potential financial damage would be dangerously misleading as it can be seen in the predictions of economists (Nordhaus etc.) that seem suspiciously underestimate the effect of the climate crisis. For instance, DICE modellers find that a 6C warming in 22nd century would mean a decline less than 0,1% per annum in GDP for the next 130 (The green swans – BIS, 2020) years albeit this warming would definitely lead to even a global extension.

Another frequently cited problem is the arbitrary choice of social cost's discount rate that makes all calculations based on those methods useless and frivolous, not to mention the ethical shortcomings of this approach. (Next generations may suffer terribly but with a "skilfully" and a bit misanthropically chosen high discount rates it could seem negligible for the time being.) It is essential to underline that although these problems with macroeconomic models (like DSGE) are general characteristic but meanwhile the potential scale of the damage induced by these models are by, and large reversible in case of the operation of the given economy this case is completely different. Climate change could be so disastrous for the humankind that real decision can be based on these models. As a result, the potential measures should target the enhance of system resilience not the fine-tuning of financial and economic parameters.

While the exact calculation of climate risks is almost impossible by virtue of the inherent extreme uncertainty, it does not mean that quantifying them – for example, with scenario analysis – is completely futile. Firstly, risk numbers should not be taken by face value but rather as an orientation that is apt to identify a trend or makes a comparison between companies, banks possible. Secondly, the need (or requirements) to systematically thinking about climate risks itself helps to raise awareness that eventually could lead to, thirdly, integrating climate risks into strategies and risk management procedures and systemic disclosure of climate-related risk.

The main channels through climate change could have an impact on financial sector are depicted on the following picture.



Source: The green swan (BIS) – 2020 / DG Treasury 2017

Physical risk: the direct connection between events (extreme weather, floods, devastating droughts etc.) caused by climate change and the given physical damage induced by it: damage the infrastructure, buildings, lead to losses of production in agriculture, low productivity in the labour market, mass migration, loss of working hours due to extreme risk etc. It could disrupt the supply chain and the demand side of the economy as well, that can induce monetary shocks (for example higher food prices could cause pick up in the headline inflation).

As climate change intensifies, non-insured losses can threaten the solvency of many entities (households, business), while insured losses will put continuously rising burden on the insurance sector that could even lead to higher insurance costs across the board beyond the fields subject to physical risk. Naturally, physical capital that is prone to heighten physical risk should be depreciated faster which will be reflected in the financial reporting as well. Moreover, the fat-tailed distribution of potential damage function makes the pricing of these risks very difficult.

According to the studies, some regions will benefit from a warmer climate but in lack of any functional global mechanism to re-distribute the benefit the overall effect expected to be overwhelmingly negative.

Transition risk: impairment of the assets, raw materials and products of industries with traditionally high levels of CO_2 emission, depreciation of traditional technologies and together with that, devaluation of equities and debts of companies operating in these industries (oil, coal, conventional energy, conventional vehicles, etc.). To put it briefly, transition risks are due to regulatory changes, technological innovations, new taxes associated with climate change that might have significant negative impacts on the expected cash flow of the company's stranded asset.[298]

Managing transition risk requires a holistic approach because too fast evolution towards the carbon-neutral economy could lead to considerable short term economic backlash with dangerous social tension (for example because of massive scale layoffs from carbon-intensive sectors or a rising carbon tax rate could cause inflationary shocks) that would spill over to the financial / banking sector as well. As the Bank of England former governor puts it: "too rapid a movement towards a low-carbon economy could materially damage financial stability. A wholesale reassessment of prospects, as climate-related risks are re-evaluated, could destabilise markets, spark a pro-cyclical crystallisation of losses and lead to a persistent tightening of financial conditions: a climate Minsky moment".[299]

It is essential to understand the dynamic connection between transition and physical risk: the faster the latter is managed, the faster the former intensifies and vice versa. BIS illustrates this concept in the following graph that underscores the significance of finding the optimal balancing.

Scenario	Rapid Transition	Two-degree	Business-as-intended	Business-as-usual
Corrective transition response	Very strong	Strong	Substantial	Limited
Change in temperature, 2100 vs pre-industrial era	1.5°C	2°C	3°C	4°C

Source: BIS, Green swan (2020), Wyman, O. (2019). Global fleet & MRO market forecast commentary 2018–2028.

[298] Assets that could suffer a "premature" devaluation so it becomes obsolete or non-performing like an oil reserve.

[299] Carney, M. (2016). Resolving the climate paradox. Arthur Burns Memorial Lecture, Berlin, 22.

Physical and transition risks trigger the following second-round financial stability risk with many interdependencies and feedback loops:

- **credit risk:** the ability to repay debt and the collateral value of the liabilities could deteriorate that might induce higher credit spreads and PD / LGD.
- **market risk:** the perception of climate change can change rapidly that could lead to a hectic repricing of risks; the implementation of derivates and catastrophe bonds to hedge climate risk can be a potential link also
- **liquidity risk:** this could stem from the above-mentioned risks as a secondary effect
- **operational risk:** this is not a financial sector-specific risk, but banks can also be effected for example by physical risk
- **insurance risk (underwriting risk):** due to higher than expected insurance claim payouts
- **business risk:** like reputational risk from investing brown asset

Physical and transition risk could endanger not only the financial but macroeconomic stability.

12.3. Climate change as source of monetary instability

Central banks have the experience and knowledge to react normal, cyclical shocks in by and large successful manner; nonetheless climate change is a completely different phenomenon than an economic shock. For example, climate related disaster could be a negative supply shock that push up inflation and reduce output. If inflation and output move in the opposite direction this poses a dilemma for a central bank as it has to decide whether priority should be given to output or inflation.[300] The problem is that climate change is not cyclical in nature but a persistent and more and more frequent shock that is impossible to predict exactly. The general attitude toward one-off shocks was the "look through" stance with closely monitoring possible second-round effect. This won't work with climate change so the traditional "reactive" attitude is no longer tenable. Therefore, actively supporting the transition could be deemed as a preemptive policy measure that is, per definitionem, part of the mandate. Later in this paper, we enumerate

[300] Breitenfellner, A., Pointner, W., & Schuberth, H. (2019). The Potential Contribution of Central Banks to Green Finance. Vierteljahrshefte zur Wirtschaftsforschung/Quarterly Journal of Economic Research, 88(2), 55-71.

the potential tools that could fit predominantly into the recent operational framework of the central banks.

As it can be seen, both the macroeconomic and financial risks of climate change mean considerable uncertainty that should be addressed by central banks. Therefore, in opposite to many experts' views, it would not mean an "overstepping" of their mandate to incorporate explicitly and implicitly climate change in their monetary policy. Nonetheless, it is undeniable that any measures related to this topic will have an impact on the society, so need to be examined in the sociopolitical context in order to achieve fairness in burden / benefit distribution. (It is important to note that every activity of central banks has this angle regardless of the field, not the only climate-related ones.) Sociopolitical viability of the measures – e.g. compensation mechanism within the society – requires instruments beyond the reach of the central banks so they can play one element in a bigger strategy. **Consequently, cooperation and coordination with other arms of the governments / international organisations is not only an option but a fundamental necessity.**

Climate risk and international central bank initiatives - What is the NGFS

When discussing central banks involvement with green investments, one organisation in particular needs to be mentioned. The Central Banks and Supervisors Network for Greening the Financial System (NGFS).[301] Currently, this is the only forum worldwide bringing together central banks and supervisors committed to understand better and manage the financial risks and opportunity of climate change. The network was launched in December 2017. As of June 2019, 36 members participating in three different workstreams: supervision, macro-financial and mainstreaming green finance.

It is a group of Central Banks and Supervisors willing, on a voluntary basis, to exchange experiences, share best practices, contribute to the development of environment and climate risk management in the financial sector, and to mobilise mainstream finance to support the transition toward a sustainable economy. Its purpose is to define and promote best practices to be implemented within and outside of the Membership of the NGFS and to conduct or commission analytical work on green finance.

[301] https://www.mainstreamingclimate.org/ngfs/

12.3.1. Embracing uncertainty – scenario analysis

As we already discussed the traditional models and approaches might have a strong limitation in determining the long term impacts in the future. ("Today's macroeconomic models may not be able to accurately predict the economic and financial impact of climate change" – NGFS) It could not only lead to inferior results but could encourage the decision makers to do nothing or much less than would be necessary. Therefore, policies should mainly focus on enhancing the system resilience in lieu of trying to calculate a potential nominal loss. Yet, as the saying goes "you can manage that you can measure".

The central bank can resolve this discrepancy by setting reference climate scenarios – while identifying and disclosing the principal sources of uncertainty attached to each scenario – for the participants of the financial sector.[302] Those scenarios could serve as a basis for a stress test. It is important to understand that scenarios are hypothetical constructs and not designed to deliver precise outcomes or forecasts.

In the corporate sector TCFD (Task Force for Financial Disclosure) will develop voluntary, consistent climate-related financial risk disclosures for use by companies in providing information to investors, lenders and other stakeholders. TCFD recognises the use of scenarios in assessing climate-related issues and their potential financial implications are relatively recent but believes such analysis is important for improving the disclosure of decision-useful, climate-related financial information. This table shows the positive implications and supporting reasons for using scenario analysis that is also valid in the financial industry:

[302] The green swan (BIS) – 2020 / DG Treasury 2017

Reasons to Consider Using Scenario Analysis for Climate Change

1	Scenario analysis can help organizations consider issues, like climate change, that have the following characteristics: Possible outcomes that are highly uncertain (e.g., the physical response of the climate and ecosystems to higher levels of GHG emissions in the atmosphere) Outcomes that will play out over the medium to longer term (e.g., timing, distribution, and mechanisms of the transition to a lower-carbon economy) Potential disruptive effects that, due to uncertainty and complexity, are substantial
2	Scenario analysis can enhance organizations' strategic conversations about the future by considering, in a more structured manner, what may unfold that is different from business-as-usual. Importantly, it broadens decision makers' thinking across a range of plausible scenarios, including scenarios where climate-related impacts can be significant.
3	Scenario analysis can help organizations frame and assess the potential range of plausible business, strategic, and financial impacts from climate change and the associated management actions that may need to be considered in strategic and financial plans. This may lead to more robust strategies under a wider range of uncertain future conditions.
4	Scenario analysis can help organizations identify indicators to monitor the external environment and better recognize when the environment is moving toward a different scenario state (or to a different stage along a scenario path). This allows organizations the opportunity to reassess and adjust their strategies and financial plans accordingly.
5	Scenario analysis can assist investors in understanding the robustness of organizations' strategies and financial plans and in comparing risks and opportunities across organizations.

Source: TCFD, Final report – 2017

Central Banks can use both their soft powers as well as their regulatory capabilities to encourage better disclosure in the financial sector that would then filter through into other sectors as well.

12.4. Policy responses – instruments and opportunities to increase system resilience

There is no well-defined framework for how central banks should react to climate change and the negative consequences.

As we already emphasised due to the fat-tailed distributed potential effects of climate change, the uncertainty related to time horizon, the general unpredictability of a complex system like our climate central banks need to increase the resilience of the financial system gradually in the near future rather than of reacting the materialisation of the first big shocks. Therefore, supporting already the transformation process might be the primary way of how the precautionary principle could be appropriately reflected in the monetary policy.

Some central banks already embarked on green programs others are still weighing their options. Because of the above-mentioned controversies central banks have to find the equilibrium between the much needed – but politically sensitive – measures and being too proactive that would create an illusion that central banks can solve this issue alone.

In terms of integration, the instruments into policies the next main reference points could be outlined that could serve as an orientation.[303] It is very important to note that many of the below-listed instruments are only hypothetical at this stage. Many of them are controversial because of the sometimes vague boundaries in central banks mandates we discussed previously.

12.4.1. Green quantitative easing (G-QE) – asset side:

Targeted purchases of green financial assets, such as green bonds, green ABS etc., in order to reduce the financing cost of the underlying green projects. Generally, during QEs, central banks strive to be market neutral[304] to minimise the impact of relative price movements between different sectors, countries etc., i.e. to be impartial. Except for some serious contradictions in outcomes (like the potential increase of social inequality), QE worked through portfolio rebalancing channel and put upward pressure on asset prices regardless whether the given asset was part of the QE program or not. The problem of the QEs' intended neutrality in connection with climate change is evident: those central banks that also purchased private sector assets, also acquired assets of high-carbon emitting sectors. Due to the higher weight of these sectors within the economy, and in particular, the relatively high amount of their outstanding market traded debt means that central banks (ECB) overweight carbon-intensive sector at clean sectors' expense. A possible solution could

[303] The potential contribution of central banks to green finance – Andreas Breitenfellner, Wolfgang Pointner, Helene Schubert, 2019.

[304] For example, ECB has already purchased green bond in respect of neutrality principle, i.e. its holding mirrors the general market share of green bonds.

be to limit the carbon intensity of the given asset purchase program, nevertheless, it could hamper the effectiveness of the program due to relative scarcity of low carbon industries' bonds.

There is an open debate to implement a targeted G-QE program as well in which central banks would purchase only green bonds. Green bonds / ABSs should meet the prescribed standards (for example the ICMA's Green Bond Principle or the new European Green Bond framework that should ensure that the proceeds came from the bond issuances are used only for eligible green criteria etc., besides that some ESG filter could be implanted as well) in order to avoid green washing. Providing ample liquidity for these bonds can propel the whole green bond market with potential positive spillover effect to the real economy (more green investments, decreasing stranded asset risk etc.). G-QE may accelerate the transition to a low-carbon economy.[305] A G-QE can also have a strong signalling effect that could drive other market participants attention and investable cash into this area.

It is essential to note that the main obstacle in executing a normal size G-QE program is the limited volume of available green bonds in the investment-grade category. The other widespread objection against G-QE is the direct intervention in the capital allocation process that would distort the otherwise effective market forces and hurt competitiveness. Apparently, this plea is deeply entrenched in the view of some mainstream circles, nevertheless most of the experts acknowledge the problem with market allocation process (short termism, principal agent problem, "climate change is the biggest market failure" etc.) and G-QE can partly resolve these issues. As we already emphasised, central banks should not be the only player in the green game yet could be one of the main driving forces in the process.

A consensus-based proposal might be that central banks should buy only green bonds issued by development banks or supranational institutions that could use the proceeds according to their specific mandate; hence central banks would abstain from the direct capital allocation decision and retain market neutrality.

[305] Breitenfellner, A., Pointner, W., & Schuberth, H. (2019). The Potential Contribution of Central Banks to Green Finance. Vierteljahrshefte zur Wirtschaftsforschung/Quarterly Journal of Economic Research, 88(2), 55-71.

12.4.2. Green credit easing and green collateral framework – asset side

In 2012, Bank of England launched the Funding for Lending Scheme that provided banks with stable term funding at a very favourable interest rate in order to revive the lending after the credit crunch in 2008-09. Commercial banks had to meet the requirements in order to be eligible for the funding (e.g. lending growth targets). Central Bank of Hungary introduced a similar structure (Funding for Growth Scheme – Növekedési Hitelprogram) aims to refinance commercial banks' SME loans (on the condition that commercial banks provide these loans with a low, capped interest rate level). ECB's TLTRO instruments also fit into this line. To sum up, providing targeted funding in order to refinance commercial banks loans with premeditated conditions attached to it already belongs to the monetary policy toolkit.

Thus, a targeted green credit program with lower rates could fit mainly into the existing frameworks with an additional condition, namely the given credit alignment with a well-defined taxonomy. Undoubtedly, the arguments against G-QE (neutrality, distorting capital allocation etc.) are partly valid here as well, because green credit would get preferential treatment compared to normal loans. However, green credit easing would not be completely identical to G-QE because credit risk would remain in the balance sheet of the given commercial bank in the first round, although other structure could be considered, too. Against this backdrop, green credit easing could be an instrument in the transition period.

The collateral framework defines the type of eligible asset and the given haircut that can be used for monetary operation by commercial banks. Central banks could modify the eligibility criteria to consider green aspects. Basically, the option to refinances asset by central banks could encourage the issuer to create such an asset, therefore, for example, to implement higher haircuts on carbon-intensive asset – making the refinancing more expensive – can have a real impact in the real economy as well.

12.4.3. Differentiated capital requirements /prudential instruments/

Some central banks also have regulatory powers over capital requirements. Changing the capital requirements for specific exposures in order to either supporting the green lending or penalising the brown one. It is noteworthy that the first priority in determining capital requirements is the credit risk of the exposure in question, and there is a widely shared consensus that this

principle needs to be maintained. In length and details, it will be discussed in the next chapter of this book.

12.4.4. Other instruments – guidelines, soft power, signalling effect

Central banks can issue green guidelines for encouraging and helping commercial banks to provide green credit. Lack of comprehensive green standards and/or vaguely defined metrics might cause difficulties and misunderstanding whether a given loan is green or not. It could lead to reputational risk and loss of the credibility that could hamper the further spread of green finance. Aligning with these standards can be voluntary, nonetheless in the future compulsory disclosures pertaining to the standards and green adequacy could be the only way to develop. There are many green taxonomy and frameworks (initiated by the private sector like GBP or CBI, or as a result of private-public cooperation like EU taxonomy, EGB etc.) globally with different requirements but some convergence would be benign to ensure the comparability of green assets. Without standards, the work of determining what is green would fall on the investors.

By dealing with climate challenges, implementing green measures (like introducing green bond portfolio) the central bank can signal the importance of this topic. It could raise awareness not only in the financial sector but in a wider sense in the whole society, too.

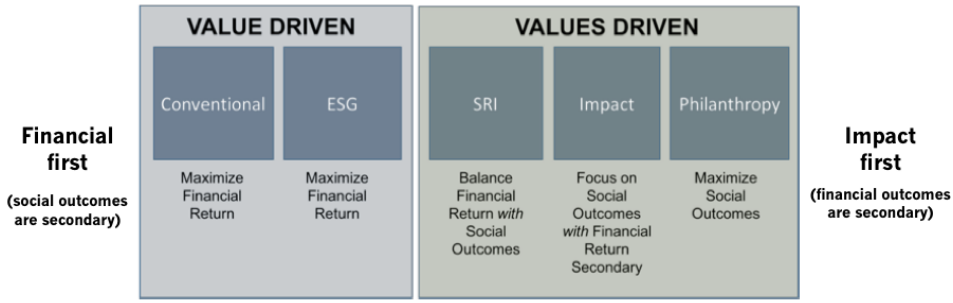
Establishing global networks (like NGFS), organising awareness-raising events also reflect this intention; furthermore they could push other agendas that could culminate into global actions as well: promoting greater integration of climate and sustainable dimension within corporate and national accounting frameworks; can call for an increased role for fiscal policy in support of the ecological transition; increase cooperation on ecological issues among international monetary and financial institutions.[306]

The green transition of the operation of the central banks like efforts to lessen ecological footprint and continuously improving their green disclosure to show example and best practices.

[306] The green swan (BIS) – 2020 / DG Treasury 2017

12.5. Sustainability in reserve management

In the first step laying down the basic and general principles is essential. **What is the difference between ESG and SRI?** Investors are often confused over what "sustainable" investing actually is because there is no consensus on the definition. This is especially the case with socially responsible investing (SRI). SRI was originally developed to allow investors to avoid companies they disliked for ethical or values-based reasons. This original form of SRI is now called "exclusions" or "negative-screen" investing. Other SRI strategies have been developed, including positive screen or thematic investing, where only companies aligned to the investors' values are bought. More recently, impact investing has become popular; here investors provide capital to innovative companies working to solve social problems like endemic unemployment, housing or education. SRI has expanded so much that some have relabeled it from socially responsible investing to sustainable, responsible and impact' investing. Many use these terms interchangeably. Below is an infographic that attempts to make meaningful distinctions between ESG, SRI and impact strategies.



Source: Vert Asset Management https://www.advisorperspectives.com/articles/2018/12/17/the-difference-between-sri-and-esg-investing

There is, of course, a spectrum of funds with varying focuses on financial and social returns. Which of the two is prioritised differentiates ESG from SRI. ESG integration is the explicit inclusion of environmental, social and governance risks and opportunities into the traditional financial analysis based on a systematic approach and appropriate research sources, ESG is about economic value. SRI is an attempt to incorporate ethics and social concerns into portfolios. SRI is about individual/organisational values.

12.6. Green reserve management / ESG integration – Central banks to walk the talk

Central Banks may have different objectives for climate-related SRI integration, which makes its application unique for every central bank and each portfolio. The two main objectives that may be pursued are (1) financial risk reduction and (2) reducing climate change, so an active contribution to the transition towards a low carbon economy seem to be the least controversial and valid objectives for central banks. The financial risk reduction objective_may include enhancing the risk-return profile of the portfolio or mitigating the climate risk of the portfolio. An environmental objective may focus on decreasing the negative climate impact of the portfolio or to achieving a positive impact in the portfolio (reduction of greenhouse gas emissions). These goals are by no means comprehensive, and central bank's portfolios may try to achieve several different goals at the same time. Portfolio objectives may vary substantially, and it is at the discretion of each central bank to decide their goals.

Moreover, the adoption of SRI practices by central banks is important as they can lead by example and demonstrate this approach to other investors and at the same time mitigate material exposures in their asset portfolios stemming from various environmental, social or governance risks as detailed above. As public institutions, central banks are subject to public scrutiny if they fail to address stakeholders' concerns related to climate change. This is especially true if a central bank calls upon the financial sector to take account of climate-related risks, but fails to appropriately address these risks in its own operations. The second part of this chapter below is dedicated to this topic and builds to a large extent on the NGFS technical document entitled: "A sustainable and responsible investment guide for central banks' portfolio management"[307]Central banks are large asset holders as they typically hold different portfolios with various goals, depending on their respective mandates. In general: (1) policy portfolios are determined by the mandate, can be either currency reserve portfolios for potential currency interventions or the execution of an asset purchase program or other monetary policy objective (2) own portfolios generally are expected to help cover operating expenses and generate returns (3) pension portfolios, and (4) third-party portfolios.

[307] https://www.ngfs.net/sites/default/files/medias/documents/ngfs-a-sustainable-and-responsible-investment-guide.pdf

The specific portfolio objectives and characteristics determine the extent to which SRI objectives can be adopted.

However, they are not comparable to other institutional investors as their investment practices are (to a large extent) dictated by the respective policy objectives. Consequently, central banks face specific challenges in the pursuit of SRI:

- **Sticking to the legal policy mandate.** The vast majority of holdings are dictated by a policy objective. It is up to each central bank to determine whether an SRI objective could be adopted without prejudice to its mandate.
- **Investing responsibly while preserving liquidity.** Central banks' balance sheets largely consist of supranational and high-grade sovereign debt in many cases with short duration. The adoption of SRI is less straightforward for these asset classes.
- **Safeguarding independence and preventing conflicts of interest.** Since central banks act as independent agents, any conflicts of interest arising from their investment practices should be prevented.

12.6.1. Strategies

The section below gives a general overview of the various SRI and ESG strategies that are now employed in the financial sector.[308] While these general approaches are not new, their implementation and integration into central banks' reserve management practices still face some challenges. Some of these challenges have already been discussed above and are related to the definition of sustainable investment goals, that are in line with central banks traditional objectives and are the least controversial. Identifying the most impactful strategies may also depend on the envisioned timeline. An instant decarbonisation goal will lead to different strategies than if the central banks aim for a more significant, more profound impact over a longer period of time. Choosing the most impactful strategies as well as selecting the relevant metrics for measuring the impact and choosing among the various data providers are all part of the implementation process.

Negative screening

[308] This section builds to a large extent ont he NGFS a sustainable and responsible investment guide, 2018

Negative screening refers to restricting the investment universe on the basis of pre-selected criteria (or screens). Negative screening entails systematically excluding controversial companies, sectors or countries from the investment universe and thereby helps to address reputational risks. These exclusions can be based on global norms or values and cover companies' products and/or conduct. This strategy can be tailored to a climate-specific, environmental-specific approach. Negative screening is often seen as a first step in the adoption of SRI. This strategy may be considered by central banks with an additional objective as disinvestment signals that some business practices are deemed unacceptable and should thus not be financed. This type of strategy eliminates the possibility to engage with a company and strive for positive change. Moreover, excluding a large part of the investment universe (e.g. an entire sector) lowers diversification benefits and thus may negatively impact the risk-return profile of the portfolio. Central banks can consider exclusions based on violations of widely accepted global norms or local regulation. Exclusionary screening based on values or products may be more challenging, as these considerations tend to be subjective and often vary over time.

Best-in-class

Best-in-class is a broad strategy that involves either positive screening or index-adjusted weighting (ESG tilting) by comparing the ESG characteristics of a firm to those of its peers. Firms can be selected or reweighted based on (1) a best-in-sector approach (ESG leaders within the same sector), (2) a best-in-progress approach (also referred to as ESG momentum), or (3) a best-in-universe approach (only the highest-ranking firms, regardless of the sector). On the one hand, a best-in-sector approach allows for mitigation of ESG risks without hampering sectoral diversification within the portfolio, thus benefiting financial returns. On the other hand, lagging companies are motivated to improve their conduct. Various best-in-class strategies are already widely pursued by private investors, and they can offer a relatively straightforward solution for central banks as well. Depending on the selection or reweighting criteria, the strategy can be tailored to specific goals e.g. a climate-specific scope (e.g. a low-carbon index) as well as a broader ESG scope. In addition, a best-in-class approach may also be considered for passive investment styles. A point to consider is that the strategy is highly dependent on ESG scores or ratings which tend to vary a lot by rating provider.

ESG integration

ESG integration enhances traditional financial (risk) analysis by systematically including all financially material ESG-criteria in the investment analysis to improve the risk-return profile of the portfolio. Identification of financially material ESG criteria is not straightforward, as these tend to vary across industries, geographical locations and over time. As a result, ESG integration requires a continuous reassessment of the underlying criteria. This strategy is common amongst equity investors, who include ESG criteria in the quantitative analysis to determine whether a sufficient premium is offered for underlying (ESG) risks. Within the fixed income space, however, ESG integration is still in its infancy, partly because the extent to which ESG criteria impact credit ratings is not straightforward. This strategy is suitable for all central bank portfolios. It explicitly accounts for ESG risks without necessarily curtailing the investment universe. The case study by the central bank of Italy provides an example of ESG integration for central banks' equity investments.

Impact investing

Impact investing aims to generate an intentional and quantifiable positive impact alongside financial returns. Impact investing[309] can range from "traditional" impact investments, which consist of smaller, private allocations to social enterprises and project-type investments, to "listed" impact solutions such as equity impact funds, green infrastructure funds, even direct green infrastructure investments[310] and green bonds[311]. Supranational debt instruments could also be part of an impact investing strategy, as the proceeds are often used for economic or sustainable development. Impact investors generally employ a holistic perspective in which both environmental and social objectives are targeted.

Green bond investments

[309] https://www.mas.gov.sg/news/media-releases/2019/new-us$2-billion-investments-programme-to-support-growth-of-green-finance-in-singapore

[310] https://www.theguardian.com/environment/2019/apr/05/historic-breakthrough-norways-giant-oil-fund-dives-into-renewables

[311] https://www.mnb.hu/en/pressroom/press-releases/press-releases-2019/magyar-nemzeti-bank-among-the-first-central-banks-to-create-a-dedicated-green-bond-portfolio-within-foreign-exchange-reserves

Green bonds are fixed-income instruments that carry a green label. The proceeds of these bonds are explicitly used to finance or refinance new or existing green projects, such as those related to renewable energy. Apart from green bonds, ICMA (the International Capital Market Association) also recognises SDG bonds and social bonds. Multiple frameworks and labels exist to validate proper use of proceeds, with the Climate Bonds Standards[312] and the Green Bond Principles (established by the ICMA in early 2014) most commonly known. The European Commission's Technical Expert Group recommends the European central banks and members of the NGFS consider promoting the greening of the financial system by expressing and implementing a preference for EU labelled green bonds. Green bond investors aim to generate an explicit environmental impact by supporting companies with credible green investment propositions. While the green bond market is growing rapidly, the total estimated market size is still small and largely concentrated in Europe. Corporates and financial institutions are well-represented in the market.[313] Moreover, central banks may want to take into consideration that (1) the credit risk profile of the issuer remains the same regardless of whether the investor is holding a green or an unlabelled bond, (2) climate risks are not necessarily mitigated via green bonds, and (3) the green bond market is still in its infancy, which may add to potential pricing, liquidity and diversification concerns.

[312] Climate Bonds Initiative in 2013
[313] Climate Bonds Initiative, 2019

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Mónika Kuti

13. Responsibility and Sustainability in Finance

Manufactured (economic), human, social and natural wealth as a portfolio contributes to economic growth. *Natural capital* is an ecosystem, i.e., "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit".[314] Liquidating natural assets to build other forms of capital undermines the well-being of nations. Natural capital accounted for 47% of low-income countries of their wealth and 30% for high-income – oil and gas producing – non-OECD countries in 2014, while in high-income OECD countries, human capital is dominant.[315] In Hungary, the produced, human and natural capital types account for 38%, 58%, and 4%, respectively, as calculated from the appendix to World Bank Group's (2018) 'The Changing Wealth of Nations' publication.

Natural capital

Provisioning Services	Regulating Services	Cultural Services
Products obtained from ecosystems • Food • Freshwater • Fiber • Biochemicals • Genetic resources	*Benefits obtained from the regulation of ecosystem processes* • Climate regulation • Disease regulation • Water regulation • Water purification • Pollination	*Nonmaterial benefits obtained from ecosystems* • Recreation and ecotourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Supporting Services		
Services necessary for the production of all other ecosystem services • Soil formation • Nutrient cycling • Primary production		

Source: Millenium Assessment Report (2003) p. 57

[314] Markandya, A., Mason, P., Perelet, R., & Taylor, T. (2002): Dictionary of Environmental Economics. London: Earthscan Publications. 69

[315] World Bank Group (2018): The Changing Wealth of Nations. Building a Sustainable Future.

The supply of natural capital has become more and more limited over the past decade, while the demand for ecosystem services has increased substantially. The degradation of natural capital has made its value explicit. The Millennium Ecosystem Assessment (2003) identifies provisioning, regulating and cultural services related to natural capital, and emphasizes that multisectoral approach is needed on how to evaluate changes in ecosystem services and how to identify the interrelationship among them due to human intervention to support sustainable use by respecting diversity, resilience, thresholds in services and ecosystem health.

According to utilitarian approach, the total economic value concept of ecosystems includes the direct use values like consumption and non-consumption, the indirect use values like ecosystem services as intermediate inputs for production) and option values to use ecosystem services in the future by individuals or by others or by heirs (bequest value). The non-utilitarian approach emphasizes the ethical, religious and cultural values of ecosystems.

Natural capital has appeared as a guiding principle for several international organisations and private institutions. A World Bank-led partnership Wealth Accounting and the Valuation of Ecosystem Services (WAVES) promotes the processes on how to go beyond traditional GDP under the umbrella of the Global Program for Sustainability. Over-exploitation and depletion of natural resources are visible in GDP and are not measured. National capital accounting (NCA) for forests, land, water, ecosystems, or carbon within wealth accounting to sustain growth is proposed by the World Bank as a paradigm shift under the flag of 'beyond GDP'. Environmentally adjusted multifactor productivity has been developed as an indicator of green growth in the OECD countries in 2017. The Natural Capital Protocol developed jointly by the World Business Council for Sustainable Development, Conservation International, the International Union for Conservation of Nature and others, helps businesses measure and value their impact and dependence on natural capital.

At Stanford University, the Natural Capital (NatCap) Project aims to enhance nature and people thrive with the help of science and technology in cooperation with the Chinese Academy of Sciences, the University of Minnesota, the Stockholm Resilience Centre, The Nature Conservancy, and the World Wildlife Fund in an interdisciplinary context. Their aim is to facilitate a paradigm shift to see the world's ecosystems as capital assets that yield a flow of services. The Project combines ecosystem services science, global environmental data and worldwide communities to encourage policy, finance and management decisions.

13.1. ESG factors

Not only at the macro-level but also at the micro-level, responsibility and sustainability have become guiding principles to promote complex analytical approaches. Environmental, social and governance (ESG) factors provide a framework for harmonizing natural capital and social capital with stakeholder interests within the corporate decision-making context. ESG is a toolkit for businesses to reevaluate the so-called triple bottom line aspects in their revenue models, operations, investments, and financing. ESG factors help financial institutions, multinational companies and SMEs align their guidelines and business-as-usual processes with social responsibility and environmental sustainability.

ESG pillars and factors

Environmental	*Social*	*Governance*
• Climate change • Global warming • Green-house gasses emission • Pollution, eco-toxicity • Energy use, reduction, alternative sources • Recycling • Water disposal • Carbon footprint • Biodiversity impacts	*Workforce* • Absenteeism rate, retention, diversity • Diversity • Training and development • Health, safety, wellness, work-life balance • Fair labour practices, living conditions *Product* • Life-cycle use impact • Packaging and pricing • Product safety, responsibility *Customer* • Customer health and safety • Ethical advertising • Privacy *Community* • Human rights • Community engagement, philanthropy • Volunteerism	• Management, • Executive compensation, • Policies, standards, codes • Audits, • Internal control, • Shareholders' rights • Board independence • Transparency • Ethics • Related-party transactions

ESG facilitates investors to assess corporate performance beyond financial measures. Sustainable companies apply ESG standards and policies to their operations in a transparent manner.

ESG risks are associated with the environment, human health, and governance practices. Environmental risks arise from the negative effect on land, water, air, and ecosystems, including pollution, emissions, and climate impacts. Reducing environmental risks lowers regulatory, litigation and reputational costs. Social risk management contributes to health, safety, work-force morale, low level of absenteeism, reduced turnover, protected human rights, product integrity, and community engagement programs. Socially sustainable companies reduce the human costs of doing business by fair practices applied for managing the relationships with employees, workers in the value chain, customers, and local communities. Products that ignore public health issues can have an adverse material impact on the manufacturers. Governance risks are linked to executive compensation, business ethics, competitive corporate behaviour, litigations, or lobbying.

The forms of ESG reporting range from sustainability reports, CSR reports, eco-reports to corporate accountability reports. Sustainability reports are ways to meet investors' expectations to provide data to ESG metrics. Integrated reporting, i.e. a financial report and a sustainability report, combine disclosures on financial, social and natural capitals. CSR reports are diverse in users and use, in topics, in objectives, in measurements, voluntary nature, long-term horizon, and the role of externalities are further characteristics.[316] Measuring, collecting and reporting relevant information in ESG disclosures, media presence, and CSR activities require financial resources, so it seems reasonable that companies would opt for sustainability reports and performance if cash flows from reputational capital or brands, and the value-added by advantageous risk assessment from rating agencies and local communities are higher than related costs. According to a survey on how traditional investment professionals make decisions, the relevance to investment is the most important factor in ESG reporting beyond product strategy or ethical considerations.[317] Sustainability reports can be viewed as a form of self-insurance to protect brand value against reputational risks.

The link between Corporate Social Responsibility (CSR) and Financial Performance (FP) has been under scrutiny for many years in financial research.

[316] Christensen, Hans Bonde and Hail, Luzi and Leuz, Christian, Adoption of CSR and Sustainability Reporting Standards: Economic Analysis and Review (July 27, 2019). European Corporate Governance Institute - Finance Working Paper No. 623/2019.

[317] Amel-Zadeh, Amir and Serafeim, George, Why and How Investors Use ESG Information: Evidence from a Global Survey (July 1, 2017). Financial Analysts Journal, Forthcoming.

The challenges to identify a common ground for the two fields are as follows:[318]

- different definitions and metrics of both CSR and FP,
- conflicting hypothesis between the two areas,
- diverse CSR datasets and factors among industries, countries, and timeframe of focus,
- and varieties of econometric models.

More standardized and measurable metrics can facilitate comparability and decrease disagreement among ESG data providers.[319] Global Reporting Initiatives standards are one of the most influential frameworks in this field. In 2013 Sustainability Accounting Standards Board (SASB) developed a conceptual framework for publicly listed corporations in the U. S. on the key definitions of sustainability accounting and disclosures, including evidence-based materiality, industry focus, decision-usefulness, and cost-benefit analysis. Companies – reporting material sustainability information in line with the standards set by SASB – show higher stock price informativeness.[320] The trend of the transition to full ESG integration has started in the financial sector.

Information asymmetry problems associated with ESG reporting may lead to adverse publicity, lobbying, or boycott campaigns by consumer or pressure groups[321] or divestment by socially responsible investors.[322] Companies with debt overhang or financial constraint, and firms with old technologies in the pollution producing industries might have difficulties covering the costs of

[318] Brooks, Chris and Oikonomou, Ioannis, The Effects of Environmental, Social and Governance Disclosures and Performance on Firm Value: A Review of the Literature in Accounting and Finance (November 4, 2017). British Accounting Review, Forthcoming.
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[322] Willis, A. (2003): The role of Global Reporting Initiative's Sustainability Guidelines in the social screening of investments Journal of Business Ethics 43(3), 233–237.

sustainability reports, so they are less likely to report.[323] Greenwashing happens where firms make attempts to improve their performance for presentational purposes.[324]

13.2. Challenges to ESG integration into finance

The lack of ESG integration and implementation at companies is mainly owing to the lack of understanding of the link between a firm's environmental performance (EP) and its financial performance (FP).[325] The authors argue that there are three major reasons for problematic ESG integration: the lack of universally accessible, the quality ESG data; the dominance of investors' short-termism in hypercompetitive data-driven investments; and the inefficient use of ESG data. The latter refers to the trade-off between the cost of ESG data collection and analytics, and the expected return achieved by the innovative approach, considering the investment time horizon. Reliability, granularity, freshness, actionability, and scarcity of data are the main dimensions for investment decisions. CFA Institution (2018) published a paper on 'Guidance and Case Studies for ESG Integration: Equities and Fixed Income' which is a detailed practical toolkit for financial professionals, showing not only the theoretical challenges in valuation techniques, risk management, and portfolio theory but also the versatility of empirical methods and proprietary metrics along a wide range of corporate best practices.[326] 'Mainstreaming sustainable investing' is another publication of the CFA Institute Research Foundation, which summarizes how ESG can be integrated into financial factors and indicators.[327]

13.2.1. ESG integration into financial intermediation

Institutional investors are under pressure from governments, pensioners, eco-friendly fund providers, and other stakeholders to form socially responsible and sustainable portfolios. The investment industry is struggling with how to

[323] Stanny, E. and Ely, K. (2008): Corporate environmental disclosures about the effects of climate change Corporate Social Responsibility and Environmental Management 15, 338–348.
[324] Schaltegger, S. and Burritt, R.L. (2010): Sustainability accounting for companies: Catchphrase or decision support for business leaders? Journal of World Business 45, 375–384
[325] In, Soh Young and Rook, Dane and Monk, Ashby H. B., Integrating Alternative Data (Also Known as ESG Data) in Investment Decision Making (May 1, 2019).
[326] CFA Institute (2018): Guidance and Case Studies for ESG Integration: Equities and Fixed Income.
[327] Greis, Michael, Mainstreaming Sustainable Investing (October 25, 2018). CFA Institute Research Foundation Publications, October 2018, Volume 4, Issue 7,

incorporate ESG scoring or individual ESG pillars into theoretical approaches and practical asset allocation decisions. The multi-attribute value function of investors is aligned with the interest of companies and their stakeholders. Traditional efficient market hypothesis and portfolio theories focus on the value creation in risk and return context; meanwhile, an alternative paradigm of adaptive markets is proposed by Shoenmaker and Schramade for a long-term investment approach.[328] According to their adaptive market hypothesis, asset allocation is based on long-term value creation, performance measures include both financial and extra-financial data, and transition preparedness leads to financial, social and environmental value maximization.

Institutional investments

Nowadays, ESG criteria as extra-financial information are driven by alternative data boom based on unconventional digital data collection. Financial service providers have adopted alternative data sources from satellites, smart technologies and use data science for evaluating cash flow potential and risk-adjusted returns for investment projects. Data science is a more relevant paradigm for ESG investors than financial economics.[329] The shift from traditional financial data to alternative data is underway in the financial sector to help investors make better decisions. ESG information and data are beyond conventional financial reporting, which may lead to higher competitiveness and extra profit. ESG data as a form of alternative data has special importance for financial managers at socially and environmentally responsible companies, ESG rating agencies, and socially responsible investment (SRI) funds. The need for standardization in ESG rating has increased in the sector. The Global Initiative for Sustainability Ranking (GISR) aims at helping financial markets agents adopt Sustainable Development Goals and global sustainability agenda; facilitated the transformation of corporate valuation in 21th century to the preservation and enhancement of all forms of capital, be it human, intellectual, natural, social or financial; and offers a voluntary accreditation process.

Over the years, the shift from single-dimensional environmental performance measures to multifaceted properties has increased the complexity of ESG research in finance. New interdisciplinary and innovative analytics are integrated into financial services to tackle the interconnectedness between huge

[328] Schoenmaker, Dirk and Schramade, Willem (2019): Principles of Sustainable Finance (November 11, 2018). Principles of Sustainable Finance, Oxford University Press, 2019.
[329] Hoepner, Andreas G. F., Financial Data Science for Responsible Investors (August 11, 2016). Forthcoming 10-4-10 Anniversary Book, Environmental Agency Pension Fund, Bristol, UK.

amounts of environmental, social and financial data. The demand for green and sustainable bonds, social bonds, climate bonds, green loans, sustainability-linked loans, and ESG ratings is developing sustainability-related financial ecosystems. New financial service providers have emerged over the past years in sustainability. Alonso and Marqués summarized new suppliers and services, new financial products, financial risk management, and technological innovation in sustainability-related to financial services.[330] They identify the following new sustainable service providers:

- Second Party Opinion (SPO) providers: Vigeo-Eiris, Imug, CICERO, Robecoo, Sustainalytics, ISS-oekom,
- External verification: Sustainalytics, ISS-oekom,
- Rating companies: Beyond Ratings,
- Certifications: CBS.

Traditional financial service providers such as MSCI, Dow Jones, Deloitte, KPMG, PwC, EY, Moodys, S&P, or Fitch have adopted ESG into their activities. The ESG ratings provided by several rating agencies are not homogenous, unlike credit ratings. ESG is integrated into price-earnings, price-to-book, price-to-sales, price-to-cash flow or the dividend yield, earnings growth, sales growth, cash flow growth, book value growth in security valuation methods applied by investment companies. ESG ratings are used by investment funds and other financial institutions for research, portfolio selection, monitoring, and performance assessment to incorporate ESG into all asset classes and investment strategies. Institutions with longer investment horizons have a better sustainability footprint.[331] Sustainability Investment Awards are available for the best practices in the financial sector: the best impact debt fund, the best infrastructure fund, the most transparent – ESG relevant – credit rating agency, the best-fixed income ESG fund, the best social fund, the best impact initiative for ESG, the ESG initiative of the year, the best ESG hybrid fund, the best initiative for ESG investment process, the best ESG reporting by an asset or fund manager, the best-fixed income ESG research, the best ESG data provider for investors, the best ESG index provider, and the best environmental fund awards were granted in 2019 among many others.

[330] Alonso, Andrés and Marqués, J. Manuel (2019): Financial Innovation for a Sustainable Economy (October 18, 2019). Banco de Espana Occasional Paper No. 1916 (2019).
[331] Gibson, Rajna and Krueger, Philipp (2018): The Sustainability Footprint of Institutional Investors (July 31, 2018). Swiss Finance Institute Research Paper No. 17-05; European Corporate Governance Institute (ECGI) - Finance Working Paper No. 571/2018.

Kaiser demonstrates evidence on how to build style and momentum portfolios with better sustainability ratings and higher risk-adjusted returns.[332] Better ESG reduces perceived tail risk.[333] Investors can have long positions on companies with low ESG and short firms with high ESG to benefit from ESG premium.[334] The life cycle of ESG conformity is relevant to portfolio return.[335] The ESG excellence out-performance has disappeared after the financial crisis in equity and bond prices.[336] Governance scores increase the portfolio performance in Europe and North America, and better ESG scores reflect lower risks.[337] According to other research findings, the environmental factor from the ESG pillar is more prevalent in North America; governance factor performs better in Eurozone.[338] Socially responsible investors relax financing constraints for responsible companies and internalize social costs.[339]

Doyle identifies ESG rating biases towards large companies, areas of high reporting standards, oversimplified industry ratings, and he emphasizes inconsistencies between rating agencies.[340] There is a positive relationship between ESG rating disagreement and stock returns.[341] ESG integration paradox still remains: corporate performance on ESG is normally distributed; only a few firms can show up alpha; thus, only a few asset managers adopted the strategy.[342] Reporting fatigue, a web of confusion, problematic transparency, and credibility issues are the challenges the ESG initiative industry is

[332] Kaiser, Lars (2018): ESG Integration: Value, Growth and Momentum. SSRN (January 20, 2018).
[333] Shafer, Michael and Szado (2018): Edward, Environmental, Social, and Governance Practices and Perceived Tail Risk. SSRN (July 26, 2018).
[334] Lioui, Abraham (2018): ESG Factor Investing: Myth or Reality? SSRN (October 24, 2018).
[335] Conen, Ralf and Hartmann, Stefan (2019): The Hidden Risks of ESG Conformity - Benefiting from the ESG Life Cycle. SSRN (June 30, 2019).
[336] Gerard, Bruno (2018): ESG and Socially Responsible Investment: A Critical Review. SSRN (December 28, 2018).
[337] Bruder, Benjamin and Cheikh, Yazid and Deixonne, Florent and Zheng, Ban (2019). Integration of ESG in Asset Allocation. SSRN (October 25, 2019).
[338] Bennani, Leila and Le Guenedal, Théo and Lepetit, Frédéric and Ly, Lai and Mortier, Vincent and Roncalli, Thierry and Sekine, Takaya (2018): How ESG Investing Has Impacted the Asset Pricing in the Equity Market. SSRN
[339] Oehmke, Martin and Opp, Marcus M. (2019): A Theory of Socially Responsible Investment. SSRN (October 10, 2019).
[340] Doyle, Timothy M. (2018): Ratings that Do Not Rate. The Subjective World of ESG Rating Agencies. American Council for Capital Formation.
[341] Gibson, Rajna and Krueger, Philipp and Riand, Nadine and Schmidt, Peter Steffen (2019), ESG Rating Disagreement and Stock Returns. SSRN (August 6, 2019).
[342] Cappucci, Michael (2017): The ESG Integration Paradox. SSRN (June 8, 2017).

facing.[343] Institutional investors are exposed to vulnerabilities in digital footprints, misuses of fast-evolving machine learning algorithms, and the unawareness that sustainability data as assets can turn into liabilities; therefore, the threat of exploitation is a challenge, data defense is more and more important for the industry.[344] The responsibility in sustainability-driven alternative data use is a newly emerging field in ESG investing.

Banking services

Banks that build sustainability credentials can help their corporate clients assess their ESG ranking, compare their environmental, social and governance performance with peers, highlight under-performance in certain pillars in ESG rating and collateral valuation. Companies can be upgraded or downgraded based on changes in ESG risk. Sustainability-linked loans aim at motivating corporate borrowers to achieve sustainability performance targets, such as better ESG scoring, over the loan period. Loan terms can be tied to the sustainability performance of the borrower; thus, corporate commitment to sustainability can reduce the cost of debt.[345] Improved overall ESG rating reflects social and environmental quality management and lower reputational risks for the lender. Good ESG scoring can increase debt capacity.

13.2.2. ESG integration into corporate financial practices

The traditional discounted cash flow value (DCF) models of project valuation and corporate valuation ignore ecosystem services, goods of nature, and social externalities. Complex metrics and data are needed for not only *ex-ante* financial decision making but also *ex-post* accountability. Incorporating ESG into business models, corporate strategy, and value drivers is a way for the corporation to tackle social responsibility and sustainability challenges. Value drivers of sales growth, operating profit margin, investment needs, and cost of capital can be expressed before and after ESG assessment to quantify the value-added or given up due to sustainability-driven corporate decisions. There are several links between free cash flow to firm versus social responsibility and sustainability. Value-added to corporate values by social and en-

[343] Mooij, Stephanie (2017): The ESG Rating and Ranking Industry; Vice or Virtue in the Adoption of Responsible Investment? SSRN (April 11, 2017).
[344] Monk, Ashby H. B. and Prins, Marcel and Rook, Dane (2019): Data Defense in Sustainable Investing. SSRN (October 22, 2019)
[345] Vértesy László (2020): Jog és pénzügyek a bankszektorban – általános rész. Akadémiai Kiadó, 2020. 88-89.

vironmental projects can be estimated by incremental cash flows, the opportunity cost of funds and the investment horizon. Low ESG performance destroys shareholder value.[346]

Free cash flow implications. Net operating profit after taxes (NOPAT) can reflect increases in sales from new markets and growth opportunities in responsibility and sustainability, and brand equity derived from a competitive advantage in sustainability. 88% of the sources in a meta-study reveal that companies with remarkably sustainable practices do better in operational performance and cash flow generation (Clark et al., 2015).[347] Price premiums from sustainability certificates (e.g. ISO standards) and eco-labels (e.g. EU Bio, ECO-CERT®, Oeko-Tex® for textiles) can increase gross profit margins. Costs incurred by or cost reduction achieved by implemented social and environmental projects are also incorporated into capital budgeting and corporate valuation models. For example, water scarcity means natural capital dependence and imposes risks for a beverage company, so water management and conservation of freshwater ecosystems can lead to costs and investment needs. Energy-saving programs and other resource efficiency initiatives can increase profitability in the long run. Degrading ecosystems and deforestation may harm the quality and quantity of certain commodity supply and can alienate environment-friendly customers from purchasing products, thus, incorporating natural capital valuation for business models and valuation metrics are important for decision making to identify growth opportunities and related risks.

Changes in non-cash net working capital related to social and environmental impacts are linked to supply chain management and their sustainability aspects. The following table summarizes the conceptual differences between lean, green/sustainable, eco-efficient, and eco-effective characteristics of supply chain management.

[346] Gloßner, Simon (2018): The Price of Ignoring ESG Risks. SSRN (May 18, 2018).
[347] Clark, Gordon L. and Feiner, Andreas and Viehs, Michael, From the Stockholder to the Stakeholder: How Sustainability Can Drive Financial Outperformance. SSRN (March 5, 2015).

Supply chain concepts

	Lean	Green/sustainable	Eco-efficient	Eco-effective
Kind of supply chain	Opened and closed-loop supply chain	Opened and closed loop supply chain	Opened and closed-loop supply chain	Only closed-loop supply chain
General purpose	Maximize profits through cost reduction	Improving ecological efficiency	Improving ecological and economic efficiency	Improving product in the life cycle from cradle to cradle (C2C)
Main idea	Elimination of waste	Pollution prevention	Zero: zero waste emission, zero resource use and zero toxicity	Quality in the life cycle
Focus	Focus on cost reduction and increased flexibility	Focus on sustainable development	Focus on doing things right	Focus on doing the right things
Product design	Maximize performance and minimize cost	Eco-design	Cradle to grave design	Cradle to cradle design
KPI (key performance indicator)	Cost, Service level	CO_2, eco-indicator, etc.	Integrated economic and environmental indicators	Indicators in life cycle from cradle to cradle (C2C)
Concept	Zero waste	Environmental protection	Eco-efficiency	Eco-effectiveness
Waste management	Recycling	Recycling	Recycling	Upcycling

Source: Burchart-Korol, D., Czaplicka, K., Kruczek, M. (2012): Eco-efficiency and eco-effectiveness concepts in supply chain management. Congress Proceedings - CLC 2012: Carpathian Logistics Congress. 5.

The traceability of raw material in product segregation, mass balance, or book and claim models, the environmental performance footprint, the credibility of the commitment to sustainability, or sustainable certifications are important elements of ESG issues in working capital management. Sustainability Accounting Standards Board has developed standards on how to report on corporate sustainability performance along the value chain.

Capital expenditure (CAPEX) can be associated with the additional fixed assets as investment needs derived from social responsibility and sustainability themes. Firms with high free cash flow have higher levels of corporate sus-

tainability investments.[348] Every industry has its own characteristics and sustainability-specific investment needs. AS4 CFO Leadership Network (2019) lists environmental CAPEX in the field of carbon, water, waste, energy use, greenhouse emission, water pollution,[349] climate change adaptation, land use, visual amenities; and social CAPEX in the field of construction noise, access to health care, health and safety, volunteering, cultural heritage, traffic patterns, and community cohesion. BREEAM rating **(sustainability assessment method for master-planning projects, infrastructure and buildings) or Energy Performance Certificate (EPC) rating, for example, can increase asset values.**

***Cost of capital implications*.** The conventional wisdom would assume that managing environmental and social risks lowers the firm risk premium; thus, the weighted average cost of capital; and increases enterprise value. ESG-adjusted beta is a way to integrate material environmental and social risks into valuation practices. Scientific evidence from the international literature is mixed on the impact of sustainability on the cost of capital and asset prices. Some research articles are in line with basic logic. ESG risks lead to long-term negative stock returns.[350] The higher the engagement in CSR activities, the lower the cost of equity.[351] Countries with better ESG performance have fewer default risks and lower sovereign bond spreads.[352] Although, some scientific research findings lead to results that contradict the previous statements. International voluntary adaptors of integrated reporting are associated with higher market value and expected future cash flows, but not with the implicit cost of capital.[353] A sustainable capital asset pricing model (S-CAPM) was developed by Zerbib to demonstrate how sustainable investing

[348] Gul, Ferdinand A. and Ng, Anthony C., Agency Costs of Free Cash Flows and Investments in Business Sustainability. SSRN (Jan 20, 2017).
[349] A4S Accounting for Sustainability (2019): CAPEX DEEP DIVE. and A4S CFO Leadership Network (2019): Essential Guide to CAPEX.
[350] Gloßner, Simon (2018): The Price of Ignoring ESG Risks. SSRN (May 18, 2018).
[351] Matthiesen, Marie-Louise and Salzmann, Astrid Juliane (2015) Corporate Social Responsibility and Firms' Cost of Equity: How Does Culture Matter? SSRN (November 1, 2015). Cross Cultural and Strategic Management 24, 105-124
[352] Capelle-Blancard, Gunther and Crifo, Patricia and Diaye, Marc-Arthur and Scholtens Bert and OUEGHLISSI, Rim (2016): Environmental, Social and Governance (ESG) Performance and Sovereign Bond Spreads: An Empirical Analysis of OECD Countries. SSRN (November 22, 2016).
[353] Martinez, Carlos (2016): Effects of Integrated Reporting on the Firm's Value: Evidence from Voluntary Adopters of the IIRC's Framework (November 26, 2016).

affects asset prices: there is a green investing taste premium.[354] The ESG risk premium is due to firm-specific ESG characteristics and not to ESG beta.[355]

***Investment horizon implications*.** Social responsibility and environmental issues would require a long-term investment horizon, which is – in many cases – in conflict with conventional investor short-termism. The willingness of long-term investors to invest in firms with higher CSR scores increases.[356] The time value of money concept does not consider inter-generation equity and sustainability, and the capital budgeting techniques based on the time value of money reject certain sustainability projects which reach a positive net present value over a long-term horizon (Baur and Lagoardo-Segot, 2015).[357]

The concept of sustainable shared value creation has been developed by Porter and Kramer (2011) where continuous sustainability performance improvements are pursued by companies.[358] There are many sustainable management tools for sustainable project valuation for businesses. Traditional management concepts and valuation techniques are extended with environmental and societal value creation efforts. Liensen provides a list of these approaches:[359]

- *Life Cycle Analysis* quantifies the harmful environmental and social effects through the whole life cycle of the product or service;[360]

[354] Zerbib, Olivier David (2018): A Sustainable Capital Asset Pricing Model (S-CAPM): Evidence from Green Investing and Sin Stock Exclusion. SSRN

[355] Ciciretti, Rocco and Dalo, Ambrogio and Dam, Lammertjan (2019): The Contributions of Betas versus Characteristics to the ESG Premium. CEIS Working Paper No. 413.

[356] Sealy, Chezham and Agoglia, Christopher P. and Piercey, M. David (2019): When Doing Good Backfires: The Effects of Corporate Social Responsibility Fit on Long- and Short-Term Investors. SSRN (September 1, 2019).

[357] Baur, Dirk G. and Lagoarde-Segot, Thomas (2015): The Contradiction of the Time Value of Money and Sustainability. SSRN (May 11, 2015).

[358] Porter, Michael E. and Kramer, Mark R. (2011): Creating Shared Value. Harvard Business Review. January-February. 62-71

[359] Liesen, A., Figge, F., & Hahn, T. (2013). Net Present Sustainable Value: A New Approach to Sustainable Investment Appraisal, Strategic Change. Strategic Change, 22, 175–189. and Tyteca, D. (1996): On the Measurement of the Environmental Performance of Firms – A Literature Review and a Productive Efficiency Perspective. Journal of Environmental Management 46:281-308

[360] Frankl, P., and F. Rubik. (2000): Life Cycle Assessment in Industry and Business: Adoption Patterns, Applications and Implications. Berlin and Heidelberg: Springer.

- *Full Cost Assessment and Total Cost Assessment* integrates social and environmental costs into cost analysis;[361]
- *Sustainability Management Systems* sets targets, monitors financial, social and environmental impacts;[362]
- *Sustainability Balanced Scorecards* is the extension of Kaplan and Norton's Balanced Scorecard with environmental and social issues;[363]
- *Total Quality Environmental Management* (Global Environmental Management Initiative) aims at continuous improvement in processes of environmental quality;[364]
- *Sustainability Key Performance Indicators* quantifies efficiency ratios in the social, environmental and financial performance;[365]
- *Green Shareholder Value* links environmental and social issues to economic value;[366]
- *Net Present Sustainable Value* and Rate of Sustainability integrate sustainability issues into the traditional NPV method.[367]

Return on Sustainable Investment (ROSI) approach is based on material sustainability strategies, financial and societal value drivers, related cost-benefit analysis, and NPV calculation.[368] The authors present a case study on how sustainability projects can create greater customer satisfaction (no discounts), better talent retention (increased revenue), more technological innovation

[361] Gale, R. J. P., and P. K. Stroke (2001): Environmental Cost Accounting and Business Strategy. In Handbook of Environmentally Conscious Manufacturing, edited by C. N. Madu. Norwell: Kluwer Academic Publishers, 504.

[362] McElhaney, K. A., M. W. Toffel, and N. Hill (2002): Designing Sustainability at BMW Group: The Designworks/USA Experience. Berkeley: Center for Responsible Business, University of California

[363] Figge, F., T. Hahn, S. Schaltegger, and M. Wagner (2002): The Sustainability Balanced Scoredcard – Linking Sustainability Management to Business Strategy. Business Strategy and the Environment 11:269-284.

[364] Global Environmental Management Initiative (1993): Total Quality Environmental Management – the primer. Washington: Global Environmental Management Initiative, 5.

[365] Keeble, J. J., S. Topiol, and S. Berkeley. (2003): Using Indicators to Measure Sustainability Performance at a Corporate and Project Level. Journal of Business Ethics 44 (2-3):149-158.

[366] Reed, D. J. (1998): Green Shareholder Value, Hype or Hit? Washington: World Resources Institute

[367] Liesen, A., Figge, F., & Hahn, T. (2013): Net Present Sustainable Value: A New Approach to Sustainable Investment Appraisal, Strategic Change. Strategic Change, 22, 175–189

[368] Atz, Ulrich and Van Holt, Tracy and Douglas, Elyse and Whelan, Tensie, The Return on Sustainability Investment (ROSI): Monetizing Financial Benefits of Sustainability Actions in Companies (July 8, 2019). Review of Business: Interdisciplinary Journal on Risk and Society 39, no. 2, 1–31.

(cost reduction), better media coverage (avoiding revenue loss), higher operational efficiency (lower costs), better risk management (avoiding revenue loss), improved sales (price premium, increase in demand, new revenue streams), improved supplier relationships (reduced volatility in the corporate ecosystem, avoiding revenue loss), and emission avoidance (more value-added to stakeholders).

Social and environmental projects have real option characteristics, including growth, expansion, contraction, postponement, abandonment, or staged options. The present value of growth opportunities can be vulnerable to air pollution, carbon emissions, child-labour violations, deforestation water shortages, or worker health and safety issues. The sustainability-related real option valuation methods are beyond the scope of this chapter.

The latest models integrate data science and multidisciplinary approaches into investment decisions. The Natural Capital Project at Stanford University emphasizes that "ecosystems yield a flow of services that are vital to humanity, including the production of goods (e.g., food), life-support processes (e.g., water purification), and life-fulfilling conditions (e.g., beauty, opportunities for recreation), and the conservation of options (e.g., genetic diversity for future use)."[369] The Project uses artificial intelligence based on data sources from social media, satellite imagery, and human movement data; models ecosystem services at a global scale; studies the resilience of human and natural systems, and the importance of vital ecosystems services in health. **The Project makes efforts to balance the social, environmental and economic goals of different entities.** The free, open-source InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) Software covers models for carbon, crop pollination and production, habitat quality, marine fish aquaculture, reservoir hydropower production, urban cooling, wave energy, habitat risk assessment, offshore wind energy, scenic quality, recreation, and water purification, to name a few. It quantifies returns in biophysical terms and economic terms (e.g. net present value).

As a whole, it can be concluded that there is no consensus on the best valuation model for integrated analysis. "Those that monetize costs and benefits have the advantage of a common comparable measure, but conversion can be subjective and complex".[370] Technology-driven innovation opens up new models on how to value projects in complex systems.

[369] Source: https://naturalcapitalproject.stanford.edu/software/invest
[370] A4S Accounting for Sustainability (2019): CAPEX DEEP DIVE

13.3. Green/sustainable finance

Traditional finance models assume that natural resources are abundant, and shareholders' wealth maximization is the ultimate target of corporate operating, investment and financing activities. Sustainable finance makes an effort on how to bridge the gap between corporate environmental sustainability, data innovation and financial metrics. Sustainable finance is an integrated framework for the productive allocation of funds for economics, social and environmental projects at companies, balancing the trade-off between sustainability goals. Sustainable finance is a means of reaching sustainable development goals.[371] The combination of material environmental, social and governance factors with traditional financial metrics is leading to a paradigm shift. Sustainable finance can contribute to a transition to a low-carbon and circular economy by

- pooling funds from socially and environmentally responsible investors,
- providing funds to sustainable companies and projects,
- monitoring sustainable investments and managing the conflicts of interests among stakeholders,
- assessing sustainability risks of future cash flows for valuation purposes; and applying different social and environmental scenarios in valuation.

The EU Sustainability Action Plan aims to:

- reorient capital flows towards sustainable investment in order to achieve sustainable and inclusive growth;
- manage financial risks stemming from climate change, resource depletion, environmental degradation and social issues; and support transparency and long-termism in financial and economic activity.

13.3.1. Green finance

In the European Union policy context, green finance is a means to achieve environmental, social and governance goals through financial intermediation by channeling investments into more sustainable technologies and businesses, finance growth in a sustainable way in a long-term horizon, and contribute to a low carbon, climate-resilient, resource-efficient and circular economy. Financial institutions are seeking how to include ESG considerations in financial instruments, risk assessment processes, and decision-making frameworks. Green Bond Principles, Moody's Green Bond Assessment,

[371] Vértesy László (2014): Az állami beavatkozás joga és hatékonysága. Nemzeti Közszolgálati Egyetem. 120-121.

and Standard & Poor's Evaluation are examples for assessment frameworks. EU green bond standards have been set up.

Green finance refers to any financial instrument or investment (equity, debt, guarantee or grant) issued in exchange for the delivery of positive environmental externalities. The financial sector can play a role in green transformation. Green finance is a means to motivate environmentally friendly investors towards green projects. UK's Green Finance Strategy (2019) has three pillars: greening finance, financing green, and capturing opportunity.[372] UK Green Finance Taskforce, for example, aims at boosting investment into innovative clean technologies, driving demand and supply for green lending products, setting up Clean Growth Regeneration Zones, improving climate risk management with advanced data, building a green and resilient infrastructure pipeline, and issuing a green government bond.

The issuance of corporate green bonds is associated with positive announcement returns, increasing long-term value and operating performance, improved environmental performance, better green innovations, and more long-term and green investors.[373] Green bonds are issued at a premium compared to conventional corporate bonds.[374] Green bonds are traded at lower prices and higher yields than brown (standard) bonds.[375]

Green banking regulations include guidelines for environmental risk assessment (environmental due diligence, environmental risk management), banks' own impact reduction (water and energy efficiency for bank buildings, solar panels for ATMs, carbon footprint measures, online services) and green business opportunities (green credit guarantee facilities, green credit cards, green funds).[376] For greening of the real estate holdings, the Global Real Estate Sustainability Benchmark was developed for institutional investors as an environmental scorecard.[377]

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[372] HM Government (2019): Green Finance Strategy. Transforming finance for a Greener Future.
[373] Flammer, Caroline (2018): Corporate Green Bonds. SSRN (July 5, 2018).
[374] Ehlers, Torsten and Packer, Frank, Green Bond Finance and Certification (September 17, 2017). BIS Quarterly Review September 2017.
[375] Karpf, Andreas and Mandel, Antoine (2017): Does it Pay to Be Green? SSRN (February 24, 2017).
[376] Lindenberg, Nannette and Volz, Ulrich, Green Banking Regulation: Setting Out a Framework (October 2016). Report for the Practitioners' Dialogue on Climate Investments (PDCI). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, October 2016.
[377] Bauer, Rob and Eichholtz, Piet M. A. and Kok, Nils and Quigley, John M. (2011): How Green is Your Property Portfolio? The Global Real Estate Sustainability Benchmark Rotman International Journal of Pension Management, Vol. 4, No. 1, pp. 34-43, 2011.

13.3.2. Sustainable finance typology

Schoenmaker (2017, 2018) outlines sustainable finance typology, which is summarized in the following table.[378] In traditional corporate finance or finance-as-usual approach, shareholders' wealth maximization is the ultimate goal of a business, considering risk-adjusted returns and cash flows. Financial monitoring may lead to short-termism, even if shareholder value maximization would require medium- and long-term investment horizon.

Sustainable finance typology

Sustainable Finance Typology	Value created	Ranking factors	Optimization	Horizon
Finance-as-usual	Shareholder value	F	Max F	Short term
Sustainable Finance 1.0	Refined shareholder value	F >>S and E	Max F subject to S and E	Short term
Sustainable Finance 2.0	Stakeholder value (triple bottom line)	I = F + S + E	Optimize I	Medium term
Sustainable Finance 3.0	Common good value	S and E > F	Optimize S and E subject to F	Long term

Note: F = financial value, S = social impact, E = environmental impact, I = integrated value.
Source: Schoenmaker (2017) p. 20.

Traditional corporate finance is neutral in terms of social and environmental issues. Three stages of sustainable finance make attempts to integrate socio-environmental impact into corporate strategy and financial decision making.

Sustainable finance 1.0 is the stage where financial institutions do not provide funds for so-called "sin" companies in tobacco, alcohol, drugs, arms industries or firms which pursue unfair trade practices or treat human labour in a morally unacceptable manner. Coal and fossil fuel industries are on the exclusion list of some socially responsible mutual funds nowadays. Corporate social and environmental activities are driven by economic considerations in this phase of sustainable finance: how to support cash flows, market share, competitive advantage, and shareholders' wealth by ESG spending and investments, and how to mitigate business risks and reduce costs by these

[378] Schoenmaker, D. (2017): From Risk to Opportunity: A Framework for Sustainable Finance, Rotterdam School of Management, Erasmus University, Rotterdam and Schoenmaker, Dirk and Schramade, Willem (2018): Principles of Sustainable Finance, Oxford University Press, 2019.

practices are important aspects in corporate practices. Principles for Responsible Investments (PRI), Focus Capital on the Long Term Global, and Equator Principles are examples for organisations between sustainable finance typology 1.0 and 2.0.[379]

Sustainable finance 2.0 is the stage where negative social and environmental externalities are incorporated into financial decision making to avoid risk. ESG integration into equity and debt finance, banking and insurance is the driving force of this type of sustainable finance. Environmental externalities might be priced in through taxation, or can affect reputation. Monetization of social and environmental impacts by IT, data science, environmental economics, and social life-cycle analysis are new analytical tools to quantify non-financial aspects.[380] The sum of financial, social and environmental material values add up to an integrated value. The situation when the net value between deforestation and economic gains from the woods is positive may lead to suboptimal decision making, highlighting the conflicts between undervalued ecosystem services and overvalued economic and financial returns in certain valuation models. Not only this integrated profit and loss accounting but also triple bottom line approaches are examples of sustainable finance 2.0.

Sustainable finance 3.0 reflects the opportunity-seeking attitude of financial institutions to provide funds to sustainable companies and projects in the area of healthcare, green buildings, wind farms, land-reuse projects and other responsible and sustainable projects, based on positive selection and inclusion lists. The transition from shareholders' wealth maximization to stakeholders' wealth maximization leads to conflicts of interest. In Sustainable finance 3.0, investors optimize the socio-environmental value by increasing impact and mitigating risks, assuming minimum financial value. Capital preservation is the minimum of fair financial return on sustainable investment and lending, which approach is different from traditional shareholders' wealth maximization. In reality, the majority of investors expect a risk-adjusted market rate of return on their impact investments. Impact investing, green and social bonds, impact lending, microfinance and microinsurance are the most important fields in Sustainable finance 3.0. Global Impact Investing Network and

[379] Schoenmaker, Dirk (2019): A Framework for Sustainable Finance. SSRN and Schoenmaker, Dirk and Schramade, Willem (2019): Corporate Finance and Sustainability: A Teaching Note. SSRN (November 2, 2019).

[380] True Price (2014): The Business Case for True Pricing. https://trueprice.org/wp-content/uploads/2015/02/True-Price-Report-The-Business-Case-for-True-Pricing.pdf

Global Alliance of Banking Values as organisations meet the standards of Sustainable Finance 3.[381]

In Sustainable finance 3.0, according to *legitimacy theory*, firms make efforts to acquire a social license to operate in societies.[382] An *outside-in perspective* of companies is about asking how they can contribute to solving social and environmental problems, instead of inside-out approach where they ask how they can reduce their social and environmental impact.[383] Rezaee attempts to highlight how ESG can be integrated into an agency, stakeholder, legitimacy, signaling, institutional and stewardships theories.[384]

13.3.3. SDG finance

Sustainable development goals (SDGs) were set by the United Nations General Assembly in 2015. The goals cover interrelated economic, societal, environmental and overall causes:

- Goal 1. End poverty in all its forms everywhere
- Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Goal 3. Ensure healthy lives and promote well-being for all at all ages
- Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5. Achieve gender equality and empower all women and girls
- Goal 6. Ensure availability and sustainable management of water and sanitation for all
- Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

[381] Schoenmaker, Dirk (2019): A Framework for Sustainable Finance. SSRN

[382] Omran, M. and D. Ramdhony (2015): 'Theoretical Perspectives on Corporate Social Responsibility Disclosure: A Critical Review', International Journal of Accounting and Financial Reporting, 5(2), 38-55.

[383] Dyllick, T. and K. Muff (2016): 'Clarifying the meaning of sustainable business introducing a typology from business-as-usual to true business sustainability' in Organisation and Environment, 29 (2): 156-74.

[384] Rezaee, Zabihollah, Corporate Sustainability: Theoretical and Integrated Strategic Imperative and Pragmatic Approach (March 1, 2016). The Journal of Business Inquiry 2017, 16, Special Issue (Issue 1).

- Goal 10. Reduce inequality within and among countries
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12. Ensure sustainable consumption and production patterns
- Goal 13. Take urgent action to combat climate change and its impacts*
- Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

These Goals have been extended with 169 associated targets by the 2030 Agenda for Sustainable Development, which is a plan of action for people, planet and prosperity[385].

SDGs open up new opportunities for businesses in the form of new markets, new business models, and new investment needs in the field of research and development (R&D), human resources, physical assets and other activities. United Nations Global Compact Platform on Financial Innovation for the SDGs (2019) proposes an integrated model for corporate SDG finance. Companies compete for capital based not only on their financial but also on their SDG impacts. Impact-oriented finance may facilitate bridging the SDG funding gap at the corporate level.

In accordance with the above-mentioned integrated model for corporate SDG finance, companies:

(1) develop a credible SDG impact theory based on intentional, specific, relevant, intense, balanced, comparable, measurable and integrated characteristics;
   - build new business models applying SGDs such as renewable energy, energy resilience, and efficiency, closed-loop manufacturing, product lifetime expansion, product-as-a-service, leasing vs. owning, sharing products and assets with a low use rate,

[385] Source: https://sustainabledevelopment.un.org/post2015/transformingourworld

- open up new markets and find new customers via "bottom-of-the-pyramid (BoP) models for affordable products and services, increasing income to reduce social inequality, building middle class, identifying new paying customers for health care and energy services,
- transition stranded assets,
- prioritize and align industry-level contribution under the themes of energy efficiency, green buildings, renewable energy, sustainable agriculture, sustainable forestry, water, affordable housing, education, inclusive finance, and health,

(2) measure and monitor the impact of SDG investments,

- apply effort-based methods to track resources and efforts (inputs) towards the SDGs,
- monitor and measure the quality of investments in impactful areas, set strategic goals and targets, report on SDGs related key performance indicators (KPIs), and assess and report on 15 categories of data in line with the table below:

Impact management project

Impact dimension	*Impact category*
What	1. Outcome in the period 2. Importance of the outcome to the stakeholder 3. Outcome threshold 4. SDGs and SDG targets
Who	5. Stakeholder 6. Geographical boundary 7. Baseline 8. Stakeholder characteristics
How much	9. Scale 10. Depth 11. Duration
Contribution	12. Depth 13. Duration
Risk	14. Type of risk 15. Level of risk

- apply outcome-based methods quantify outcome-based indicators (e.g. decrease in GHG emissions, a rise in income and standard of living, improved education),

(3) integrate SDG impact in corporate strategy and governance,

- translate into pro-active SDG strategic goals, targets and KPIs, assess positive outcomes and mitigate negative impacts,

- integrate monitoring of SGD strategy into oversight by the board of directors and a specialized committee, internal control and audit, and reporting.

Conclusions

The transition towards ESG integration into mainstream finance is on the way. The shift from shareholder value to stakeholder (shared) value, from traditional financial systems to sustainability-linked financial ecosystems, and the evolution of regulations and ESG standards are just a few milestones in this road to a world that respects environmental and societal values more. Technological innovation and data science are leveraging these processes to more complex analytical tools, valuation methods, business models, and best practices.

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- A4S CFO Leadership Network (2019): Essential Guide to CAPEX. https://www.accountingforsustainability.org/content/dam/a4s/corporate/home/KnowledgeHub/Guide-pdf/Capex%20(2019).pdf.downloadasset.pdf
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14. Green bond market

The international green finance segment is breaking records in the last decade, Trillions of dollars of investment are needed to fight against global warming. Realizing investment needs against climate change is relevant and there is a responsible customer base; moreover the *issuers raise money specifically for environmentally friendly projects, and* the green finance increasingly becoming the mainstream in advanced financial markets, especially: green loan portfolio, socially responsible (Environmental, social and governance, ESG-based) asset management, or just issued by bonds. On the other hand, green-labeled financial instruments are not always whether a note is truly green; regulators are working on standards to help guard against greenwashing [386].

14.1. What green bond is for?

It is important that investors are using in their investment decision-making progress an environmental-social-governance (ESG) thread. Not only risk-return test. Because ESG is also an internal control that protects investors' money. The incorporation of such criteria within financial markets' structures is becoming becomes more evident (such as Moody's, Standard & Spoor, and MSCI) have started developing green bond standards and indices to assess the environmental impact of their clients' portfolios. There is and another argument: originated in the 2015 Paris Agreement and it has a political side. At the Paris climate conference, nearly 200 countries have adopted a fixing climate deal aimed at cutting down greenhouse gas emissions (or other gases that has equivalent to the greenhouse effect and has carbon footprint) in order to limit global warming 2° Celsius above pre-industrial levels, with 66% of probability by the end of this century [387].

Such controlled forms of investment (from the other side: loans) in the financial market as they are based activity in sustainable energy, energy efficiency or water management. Alternatively, an activity based on specific indicators,

[386] Magyar Nemzeti Bank: Zöld Pénzügyek Magyarországon. https://www.mnb.hu/letoltes/zold-penzugyek-konzultacios-dokumentum.pdf (2019.06.03.)
[387] G20 Green Finance: Green finance synthesis report. http://unepinquiry.org/wp-content/uploads/2016/09/Synthesis_Report_Full_EN.pdf (2019.01.11.)

which aims to make the company more energy efficient. There can find qualitative and quantitative definitions and each has a purpose of determining grades of greenness. Of course, it is essential to set a standard and indicator for a measure of greenness. In this chapter, we will discuss this topic [388].

Green Bonds are used to financing or re-financing projects which apply the four core components of the Green Bond Principles (Use of Proceeds, Process for Project Evaluation, Management of Proceeds, Reporting), and has a clear environmental benefit. „Green projects include renewable energy, energy efficiency, pollution prevention and control, eco-efficient and/or circular economy adapted products, production technologies and processes, Green buildings, terrestrial and aquatic biodiversity conservation, clean transportation".[389] It is a direction for the public benefit and to avoid planetary destruction, all this without incurring any additional cost to investors. [390]

During the Fourth Industrial Revolution, it is negligible to focus on the waste and the productivity of the company. Building a sustainable industrial system also requires technologies for recyclable materials, or advanced waste management, better agricultural practices, stronger energy efficiency measures across sectors, and water desalinization infrastructures without question, any green industrial revolution must transform existing economic sectors and create new ones[391].

14.2. What green bonds do investors invest in?

The green financing is not about planting trees to the shop window and make handouts of it, to be socially accepted by the investors. Green Bond proceeds may only flow to projects that have positive environmental or climate effects. (see table Use of Proceeds – Green Bonds) The portfolio range is enormous;

[388] Inderst, Kaminker, & Stewart, 2012: Defining and Measuring Green Investments: Implications for Institutional Investors' Asset Allocations". OECD Working Papers on Finance, Insurance and Private Pensions.

[389] International Capital Market Association: https://www.icmagroup.org/green-social-and-sustainability-bonds/green-bond-principles-gbp/ (2019.10.23.)

[390] Perez, Carlota 2012: Financial Crises, Bubbles and the Role of Government in Unleashing. FINNOV Discussion Paper.

[391] (International Capital Market Association: Guidance Handbook- https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2019/Guidance-Handbook-June-2019-120619.pdf (2019.10.13

moreover, there is a certain view also may include communications and information technology[392].

14.3. ESG

The acronym ESG is made up of the term "Environmental, Social, Governance", i.e. it examines the impact of a given investment on the environment, society and governance issues of a given entity. At first, this may be considered too general, but the evaluation process is similar to a credit rating and the end product is an ESG rating.

In other words, ESG wants to build a bridge between broader values in the gap between short-term and long-term optimization. It is important to note that this trend is not aimed at eliminating market forces, but rather to combine financial performance with other factors in order to improve the overall social and environmental situation in the long term in a sustainable way. Of course, a more stable environmental and social situation also means lower financial risks, so the application of the ESG framework will result in decisions that are purely economically viable.

Green bond issuance can be viewed as a proxy for firms to make environmentally-friendly investments and change their ESG profiles. The issuers' stock prices increase significantly around the announcement of green bond issuance. Stock market reactions are stronger for first-time issuers than for repeated issuers and stronger for corporate issuers.

Green bonds can contribute to expanding the range of investors that issue green bonds can attract more media opportunities and can be used by efficient investors to fulfill their investment mandate. Overall, our findings suggest that existing shareholders will have a net benefit from issuing the green bonus.

14.4. What makes it green?

We will look at two kinds of standards. One is the International Capital Market Association's (ICMA) (formerly the Association of International Bond Dealers) The supranational co-operative ICMA reports and guidelines in several areas. These include Capital Market Practice, Primary and Secondary Markets, MiFID Compliance, G20 Finance Development, and: Green Social

[392] Carney Mark: Breaking the tragedy of the horizon – climate change and financial stability. https://www.bis.org/review/r151009a.pdf (2020.02.23)

and Sustainability Bond Markets. Interpretation of The Green Bond Principles (GBP) and the other is the Moody's Green Bond Assessment (GBA) concept. Of course, there are overlaps and small differences. Obviously, others are involved in certification business, but this chapter does not cover e.g. Climate Bond Initiative certifications. That was the first, but specialized only a couple of firms). The standards bring transparency to the market, although they are only recommendations.[393]

First, let us look at GBP 2018[394] , promoting integrity in the Green Bond market, according to ICMA [395] The GBP have four core components:

- Use of Proceeds
- Process for Project Evaluation and Selection
- Management of Proceeds
- Reporting

14.4.1. How it is different

An entity (which may be a state) can (also) issue capital through a bond issue. The bond is a debt security, so the investor lends to the issuer at a typically low-risk level[396].

The main difference between green bonds and conventional bonds is that the proceeds of the former must be throughout allocated for environmentally-friendly projects. Moreover, green bonds often require a more complex issuance control process even quarterly. Since at least three certification consultant companies compete with each other for certification rights, whose roles are discussed in the next subsection[397].

Green bond finance and certification

How can investors be sure that the proceeds of green bonds are invested in an environmentally friendly way, and not green-washed? There is no single global definition of what precisely constitutes an environmentally beneficial,

[393] Magyar Nemzeti Bank i.m.
[394] Climate Bond Certified: Green Bond Labels and Standards. https://www.climatebonds.net/files/files/Green%20Bond%20Labels%20and%20Standards%2010-06-2016.pdf (2019.10.23)
[395] International Capital Market Association i.m.
[396] World Bank 2016: What are Green Bonds. World Bank Treasury Department Washington DC.
[397] Climate Bonds Initiative: Bonds and Climate Change. https://www.climatebonds.net/files/files/Climate%20Bonds_Standard_Version%203_0_December%202017.pdf (2020.02.23)

but the use of proceeds and standards makes it acceptable for market participants. Some organisations have started to provide green label certifications that indicate adherence to particular definitions of green, including shades of green. Doing so can make those who want to invest and asset managers satisfied.

In this feature, we provide an overview of the state of the green bond market.

The standards emphasize how the various green farming certification mechanisms have evolved to allow for detailed and continuous evaluation. The document that green bonds issued at the time of issue had an average premium compared to traditional bonds, while in the secondary market, they performed similarly to other bonds when hedging foreign exchange risks[398].

It must be documented that green bonds are relatively exposed to financial risks related to the environment. The rest of this feature is as follows. After defining green bonds, we briefly review the growth and composition of labeled green bond issuance from two different sources. The third section examines and classifies the various green labels used in the green sector to certify the issuance of green bonds. The fourth phase focuses on green rates, financial performance and the risk of green bonds[399].

According to the Green Bond Principles; what can a green bond invest in?

Use of Proceeds

Use of Proceeds – Green Bonds

	Example
Renewable energy	Wind, Hydroelectric, Geothermal, Biomass, Ocean energy
Energy efficiency	More shift production
Pollution prevention and control	Using non-toxic or less toxic chemicals in agriculture
Clean transportation	Public trains, e-mobility
Sustainable water and wastewater management	Food Chain Reactor, bio-kinetic modelling, pollution prevention

[398] Barclays 2015: The Cost of Being Green. Credit Reseach.

[399] European Investment Bank: New People's Bank of China and EIB initiative to strengthen green finance. https://www.eib.org/en/press/all/2017-073-new-peoples-bank-of-china-and-eib-initiative-to-strengthen-green-finance (2019.10.23)

Eco-efficient; circular economy adapted products, production technologies and processes	Complex manufacturing industry– good example: isoglucose
Green buildings	Active and passive houses

Process for Project Evaluation and Selection

- the environmental sustainability objectives;
- the process by which the issuer determines how the projects fit within the eligible Green Projects categories identified above;
- the related eligibility criteria, including, if applicable, exclusion criteria or any other process applied to identify and manage potentially material environmental and social risks associated with the projects

Management of Proceeds

- The net proceeds of the Green Bond should be credited to a sub-account.
- Periodically adjusted to match allocations to eligible Green Projects
- They have to get information about the balance of unallocated net proceeds.
- High level of transparency
- Use of a third-party, independent auditor.

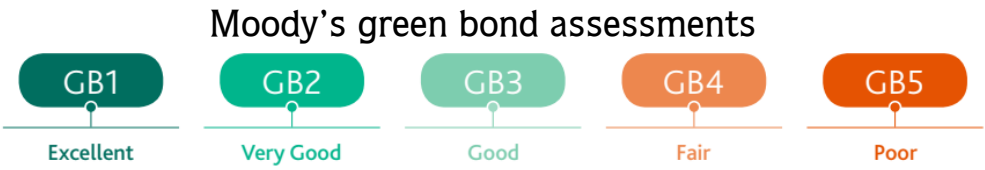
Reporting

- The annual report should include a list of the projects to which Green Bond proceeds have been allocated, a brief description of the projects and the amounts allocated, and their expected impact.
- Qualitative performance indicators and, where feasible, quantitative performance measures (e.g. energy capacity, electricity generation, greenhouse gas emissions reduced/avoided, number of people provided with access to clean power, decrease in water use, reduction in the number of cars required
- Disclosure of the key underlying methodology and/or assumptions used in the quantitative determination.
- Issuers with the ability to monitor achieved impacts are encouraged to include those in their regular reporting. [400]

Secondly, look at Moody's Investors Service: the Climate Bonds Initiative, which created the first green-bond standard in 2010. There are five different

[400] International Capital Market Association i.m.

'shades' of greenness.[401] The shade scale ranges from 1 to 5; where 1 is the darkest and most appropriate, 5 is for poor. In addition, there is a brown who is responsible for the technological innovation of coal power plants.



Bonds are debt instruments. Moody's rating is based on the weighted average below for investment bonds.

Use of proceeds	40%	Clean water
		Sustainable land use
		Sustainable waste mgmt
		Sustainable water mgmt
		Clean transportation
		Biodiversity conservation
		Renewable energy
		Climate change adaptation
		Energy efficiency
Ongoing reporting	20%	Monitoring
		Frequency and quality of reporting
		Environmental impacts
Organisation	15%	Governance
		Mission
		Framework for deployment of proceeds
		Project evaluation
Management of proceeds	15%	Allocation and tracking of proceeds
		Temporary investment practices
		Audit
Disclosure on use of proceeds	10%	Project disclosure practices
		Funding practices
		Reliance on external assurances

Moody's: A Greener Approach to Financing.

[401] Moody's: A Greener Approach to Financing. https://www.moodys.com/sites/products/ProductAttachments/MIS_Green_Bonds_Assessment.pdf?WT.z_referring-source=TB~ESGhub~GREENBONDS (2019.10.23.)

14.4.2. Comparison between the two standards

Green bond standards could be improved to highlight: the magnitude of financial risks from environmental factors in order to encourage investors further to manage these risks effectively[402].

Major differences between the two standards

	ICMA	Moody's
Use of Proceeds	Essentially the same processes... but...	
		the Moody's also covers two additional activities Biodiversity conservation Sustainable land use
Process for Project Evaluation and Selection Disclosure on use of proceeds	Environmental sustainability objectives correct use proceeds	Consideration of secondary effects, externalities
Management of Proceeds Organisation + Management of proceeds	Needed a sub-account for certification Accounting control of the money used	Organisation + Management of proceeds General audit

While Moody's determines how much lenient a valuation is by %, it gives much more room for the professional work for securities rating agencies. Moody's Green Bond Assessment: The first public methodology for rating green bonds by a credit rating agency was released in March 2016 by Moody's Investors Service. The purpose of the Green Bond Assessment (GBA) is to assess the relative likelihood of the bond proceeds being invested in support of environmentally friendly projects, in line with the Green Bond. Like credit rating products, Moody's uses a number of quantifiable factors to determine GBAs, with the explicit purpose of increasing their transparency and repeatability. A regular review is expected, similar to the way regular credit ratings are updated over a period of several years.

ICMA relies on the veracity of the projects and their accounting control.

[402] Climate Bonds Initiative: Bonds and Climate Change: The state of the market in 2016. https://www.climatebonds.net/files/files/CBI%20State%20of%20the% (2019.10.23.)

Although not part of the four core principles of the green bond, the 2015 edition of the core principles suggested that issuers of green bonds "use external certainty to confirm that they are aligned with the main characteristics of green bonds.[403]

14.4.3. Just how green are green bonds?

It is hard to measure, the shade of the bond, or find a globally accepted standard for a consistent verification. The world's biggest carbon user/emitter, China, has a different perception of the Green New Deal. China is the world's second-largest green bond issuer because they used to finance the construction of its thermal power plants. Undoubtedly, they are less polluting than their predecessors, often criticized for their method. The Oslo-based Cicero standard uses three shades of green:

- dark green for things that will lower carbon emissions in the long run like the wind energy
- medium green for things that make a good step forward such as plug-in hybrid buses
- light green for environmentally friendly steps that will not change the long-term outlook on their own, such as more efficient fossil-fuel infrastructure[404].

In addition, there is a debate as to whether the environmental or social impact of the issuer should be examined or the carbon footprint alone. Also, the arguments that solar panels produce "free" energy, and the amount of pollution that solar panels produce, often come up. Then, how much environmental damage will occur after the economic life of its liquidation. It is not a negligible argument that the efficiency of solar panels decreases radically over their lifetime. There is also a debate about the impact of wind farms on birdlife and the cost of maintaining offshore wind farms.

In any such debate, there is an argument for nuclear energy, which sounds like: that is that the cleanest energy, but any green-labeled securities will preclude investing in it.[405]

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[403] European Commission: Action plan: Financing Sustainable Growth. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0097&from=EN (2019.10.23)
[404] CICERO: Second opinions on green bonds. https://cicero.oslo.no/en/posts/single/CICERO-second-opinions (2019.10.23)
[405] Center for International Climate Research: Center for International Climate Research. https://www.cicero.oslo.no/en/posts/single/cicero-shades-of-green (2019.10.23)

14.5. Investment bonds and their risks

General and green bonds are similarly priced in the secondary markets. What investment advisors do not mention is technological advancement. In the fast-growing green sector, the (un)expected new; improved energy efficiency technology can cannibalize its predecessors[406]. General Risks with Investing in Bonds:

- Spread Risk – Corporate spread versus the risk-free government bond; the flight to safety
- Interest Rate Risk
- Industry Risk
- Default/Company Specific Risk – this can be Liquidity Risk or Solvency Risk
- Sovereign/Expropriation Risk
- Inflation Risk – the loss of purchasing power
- Option Risk – Catastrophe bonds, call options
- Foreign Exchange Risks – If holding bonds in a different currency than the investor's base currency

14.5.1. Green Bond Risk

Green bonds carry the risk of all other types of bonds, but an additional burden is a process of evaluating. The value of the project thus decreases the expected value of the bond at maturity through regular reporting, compliance with the standard and transparency. On the other hand, investors who like the low-risk level of clean investment are grateful. However, there is a greater risk: the greenwashing, so that polluting companies, who just want to look green, or some extent show some social responsibility are using the tools of green finance. For instance, most oil companies are buying green bonds or climate bonds, and they have some green or green labeled projects. As well as banks are working with green loans to financial investment in renewable energy technology e.g. solar panels. On the other side, the expansion is adding to new questions, including which indicators should be used to provide evidence of progress against sustainability objectives, and how to report on

[406] Anderson Mats and Patric Bolton (2016): Hedging climate risk. Financial Analysts Journal. vol 72/ no3.

those indicators in a consistent manner. With those challenges lying ahead, sustainable financing seems just at the start of its innovation journey. [407]

14.6. Benefits of Green Bonds

Green standards have implications for investors and policymakers. First, the estimation results can be used to build an optimal risk minimization portfolio between green bonds and conventional bonds. However, changes in estimated hedging ratios between the green bond market and the traditional bond market indicate that the optimal portfolio mix often needs updating. Second, the results also show an increase in the link between the "labeled" green bond market and the traditional bond market, indicating a convergence of yields between the "labeled" green bond market and the traditional bond market. Therefore, as the green bond market continues to grow, it is important to introduce stronger differentiation strategies between green bonds and traditional bonds in order to attract a wider range of investors. Finally, policies aimed at standardizing the rating process for green bonds and raising investor awareness will allow the green bond market to reach a wider range of investors.

Benefits for the investors	Benefits for the issuers
• Well-understood projects reduce risk exposure • Well-managed projects reduce risk exposure • Well-managed projects reduce risk exposure • Trading at a premium in secondary markets • Strengthened reputation • Deeper engagement with company management on green • more favourable taxation (usually)	• Investor diversification across regions and types • Investor engagement & "stickiness" • Strong oversubscription, yields tighter • Strengthened reputation • Alignment of CSR (or core business when pure-play) with a funding scheme

Climate Bond Certified: Green Bond Labels and Standards

The analysis of green standards contains a number of suggestions for future research. First, the analysis may benefit from using a longer time series in the future to reflect the behaviour of green bonds throughout the business cycle. Secondly, it would be interesting to look at the role of green bonds in reducing climate or environmental risks and the relationship between green

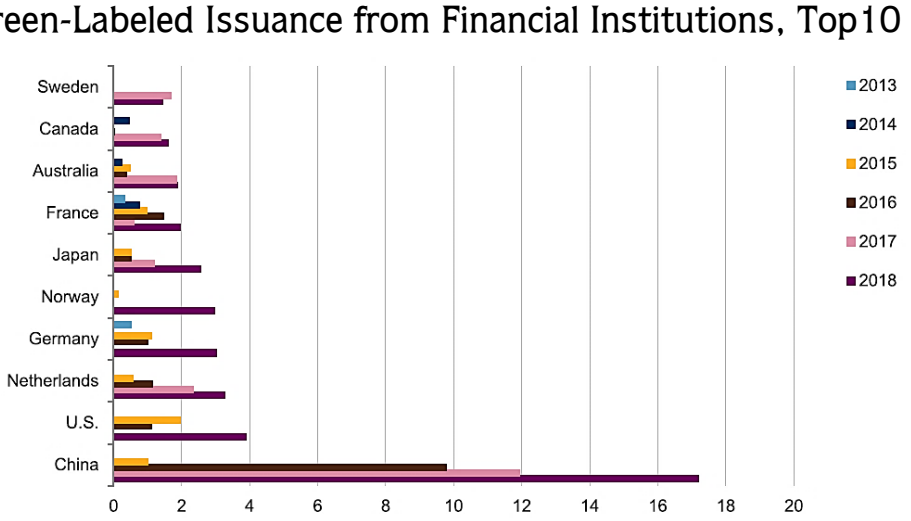
[407] S&P Ratings Direct: Green Finance: Modest 2018 Growth Masks Strong Market Fundamentals For 2019.

bonds and other financial markets, such as energy markets and stock markets[408].

Third, depending on the availability of data, future research could examine how the behaviour of green bonds changes with the type and location of issuers. Finally, a fuller understanding of the environmental impact of green bond projects would play an important role in driving the growth of this new market[409].

14.6.1. Issuers

Including the World Bank and the European Investment Bank, there are 50 countries that are selling green bonds. We can see companies also in the market or local governments and national state governments. All indications are that these issuers want to follow well-founded and socially accepted noises in international conventions. This can happen not only for recognition reasons but also for a hard material consideration. The first emerging-market green bond was issued in South Africa in 2012, later Poland opened the sovereign market in 2016, followed by the likes of France, Belgium and Ireland.



Source: Climate Bonds Initiative.

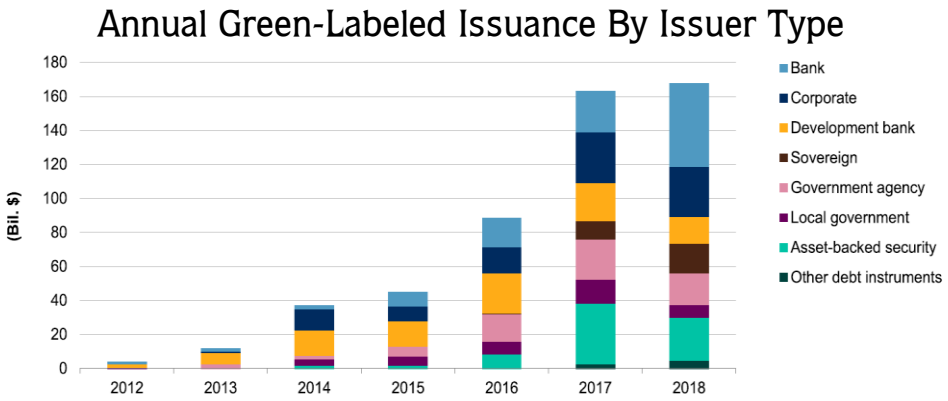
[408] World Bank (2015): Green Bond Impact Report. World Bank Treasury Department Washington DC

[409] World Bank (2016): Innovative Finance for Development Solutions. World Bank Treasury Department. World Bank Treasury Department. Washington DC.

S&P Ratings Direct: Green Finance: Modest 2018 Growth Masks Strong Market Fundamentals For 2019.

14.6.2. Market size and The Rise in Sustainable Finance

There is a fast development of new green markets as market fundamentals. That is lead to the expansion of the green bond (secondary) market with new types of issuers, and the emergence of green loans, green mortgages, and green derivatives[410].



Source: Climate Bonds Initiative.

Worth a total of $ 580 billion of the green bond was purchased in 2018. Although this is only a fraction of the total bond market, this small segment is growing [411]. According to the 2015 Paris Agreement on Climate Change, Europe needs to sell $203 billion until 2030 to achieve the emission targets [412]. In line with this, the Hungarian National Bank is acting to support green investments with interest-subsidized loans. We have seen, for example, solar panels investments or subsidized loans for energy-efficient real estate purchases in 2019.

[410] Climate Bonds Initiative i.m.

[411] Mittelman Melissa (2019): Sustainable Investing https://www.bloomberg.com/quicktake/sustainable-investing (2019.10.23)

[412] Claquin Tanguy (2019): Green bonds: a promising tool for climate change https://www.cacib.com/sites/default/files/2017-02/Proparco_Article_T_CLAQUIN_PSD_22_UK.pdf (2019.10.23)

14.7. Demand in the Secondary Market

One of the largest differences between green bonds and conventional bond markets is that liquidity tends to be lower for green bonds in the secondary market. Because many investors buying green bonds do so for impact investment reasons, they tend to hold them to maturity. However, investors still trade with green bonds, and with the growing market volume, the secondary market also grows. Still with a lower liquidity profile than conventional bond secondary markets, in any case. There are several retail green bond funds, because of funds offers, a growing variety in the market as it grows in volume and matures. The first green bond Exchange Traded Fund was launched in 2017, by Lyxor Asset Management. The European Capital Markets Union is further accelerating this process.[413] As the market matures further, instruments such as retail funds, indices, and ETFs will be increasingly used in the future[414].

The regulations of green bonds classes between AA–BBB are tighter than their comparable non-green bonds and government-related bonds, on the other hand, trade marginally wider. Besides Issue size, maturity and currency do not have a significant influence on differences in pricing but industry and ESG rating [415].

These characteristics affect the pricing of green bonds and their attractiveness to investors. As opposed to comparable bonds without a green label, a premium per issuer indicates that a significant number of investors value the label enough to give issuers additional incentive to issue branded bonds. Over time, these investors will continue to be interested in the acceptable financial performance of green bonds over time. Another aspect is exposure to credit risk associated with environmental change. The fact that green bonds support green projects does not necessarily mean lower exposure to such risks.[416]

[413] Vértesy László (2019): The legal and regulatory aspects of the free movement of capital - towards the Capital Markets Union. in Jogelméleti Szemle 2019/4.
[414] Southworth Chris (2017): The Green Bond Market: 10 years later and looking ahead. Pension Found Service. Knutsford
[415] Hachenbergv Britta and Schiereck Dirk (2018): Are green bonds priced differently from conventional bonds?. Springer Nature Limited.
[416] Becker, B., Ivashina, V. (2015): Reaching for Yield in the Bond Market. Journal of Finance

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