

III. THE SIXTH WAVE AND FUTURE OF TECHNOLOGIES

11

The Sixth Kondratieff. The Growth Engine of the 21st Century

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Abstract

Is it possible to forecast a Kondratieff cycle? The following article introduces a method that is able to predict Kondratieff cycles in their early phase and describe them in ever-greater detail during their further development. This method was first published in 1996 (Nefiodow 1996). The fifth Kondratieff still shaped economic events during this time, and the new, sixth Kondratieff was in its early stage (Fig. 1). This prediction was possible, because prior to that long wave researchers created a broad-based foundation for the Theory of Long Waves and thus demonstrated the regularity of the Kondratieff. In the second part of this article, we use this method to identify the sixth Kondratieff.

Keywords: *sixth Kondratieff, Kondratieff waves, Kondratieff cycles, basic innovation, leading industry, value chain, long cycle, fifth Kondratieff.*

Criteria to Identify and Predict a Kondratieff Cycle

To identify a Kondratieff cycle, it should be searched on four levels:

1. The technological level (Criterion 1).
2. The economic level (Criterion 2).
3. The social level (Criterion 3).
4. The time level (Criterion 4).

These levels are described below with the example of the fifth Kondratieff.

Criterion 1. The first criterion is the search for those innovations that are able to trigger and support a Kondratieff cycle. Here we follow and acknowledge Schumpeter (1961). To distinguish them from other innovations, we call them *basic innovations*. A basic innovation most notably differs from other innovations by the following characteristics: it triggers the Kondratieff cycle, definitively shapes the innovation process for several decades, creates a large new market, extensively alters society and has a life cycle of 40–60 years.

Kondratieff Waves: Juglar – Kuznets – Kondratieff 2014 326–353

Information technology was the basic innovation of the fifth Kondratieff (Fig. 1). Over five decades, it shaped technological, economic and social changes in the developed countries and turned the world into a global village in terms of information. The scientific foundation was primarily supplied by informatics and computer science. No other technology was able to even remotely exhibit comparable economic dynamics and widespread effect during the second half of the 20th century (Nefiodow 1991).

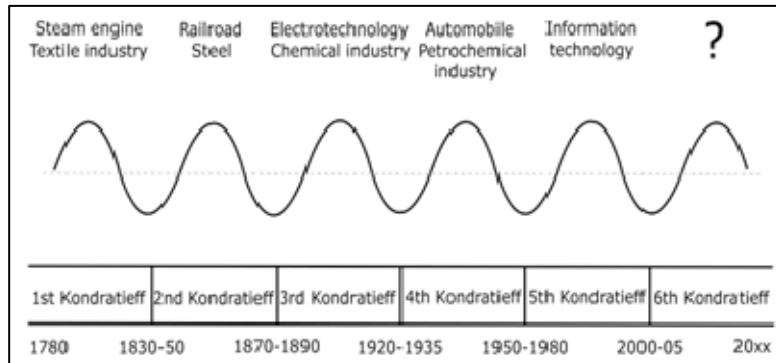


Fig. 1. The long waves of economic development

Source: Nefiodow and Nefiodow 2014.

The core of information technology was the digital computer (Fig. 2). To achieve high performance, microelectronics, software technology and data processing technology were invented. At the same time, the introduction of the computer into communication technology, office technology, industrial electronics, consumer electronics and military engineering was the prerequisite for the introduction of digital technology into these technologies, whereby their performance could be considerably increased.

The dynamics of information technology could also be seen in the extent of research and development expenditures (R&D). Towards the end of the fifth Kondratieff, more than one third of global research and development expenditures were allocated to information technology (ca. 250 billion U.S. dollars in 2003). It formed the core focus of research expenditures for all larger companies (Table 1).

Criterion 2. The second criterion pertains to the economy and consists of identifying the *leading industry* and the *value chain*. The leading industry is the industry, which newly develops thanks to the basic innovation. And it is also the one that benefits the most from the basic innovation. This leading industry acts as an engine of growth for the overall economy for the duration of the

Kondratieff cycle. During the first Kondratieff, this was the textile industry, during the fifth Kondratieff it was the information technology industry.

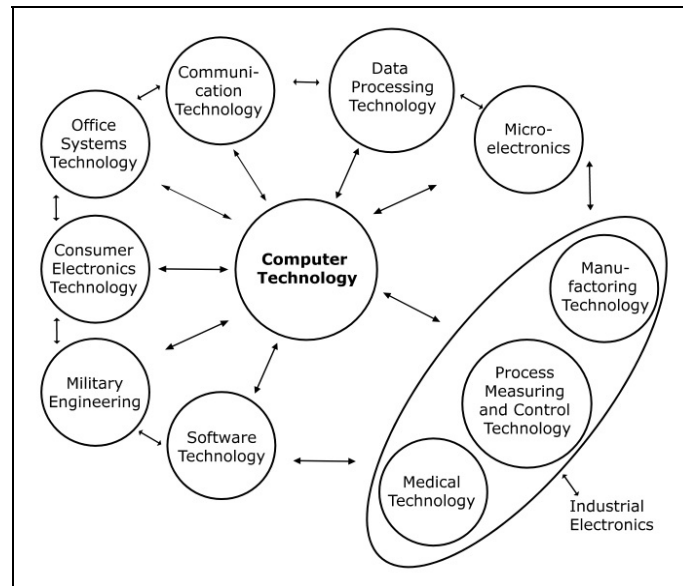


Fig. 2. The technological network of the information technology

Source: Nefiodow 1991.

For an industry to be classified as a leading industry it needs to be an economic heavyweight. As emanates from Table 2, due to its above average growth, the information technology industry skyrocketed from zero to the first place among globally manufacturing companies during the fifth Kondratieff.

To be able to properly assess the importance of a leading industry, its contribution to economic growth needs to be determined. The annual contribution of the aerospace industry for example to Germany's gross domestic product between 1980 and 2000 was below 0.7 percent. The volume of the aerospace industry was therefore too small to be able to affect the economic development overall. This industry can be classified as an important high technology industry, but not as a leading industry. By comparison, the economic growth of the USA in the 1990s was supported by the information technology industry by more than 30 percent (Fig. 3).

Table 1. 1997 research and development expenditures in the private sector (billion D-marks)

Company	Headquarters	R+D	Industry Sector
General Motors	USA	14.9	Auto/IT
Ford Motor	USA	11.5	Auto/IT
Siemens	Germany	8.2	IT/Electro
IBM	USA	7.8	IT
Hitachi	Japan	7.	IT/Electro
Toyota Motor	Japan	6.3	Auto/IT
Matsushita	Japan	6.1	IT/Electro
Daimler-Benz	Germany	5.7	Auto/IT
Hewlett-Packd	USA	5.6	IT
Ericsson	Sweden	5.5	IT/Electro

Source: Nefiodow and Nefiodow 2014 based on *Wirtschaftswoche* from November 19, 1998.

Table 2. The major industries in the manufacturing sector

Industry Sector	Total Revenue in 1997 Globally in Billion US-\$
Information Technology	1730
Automotive	1190
Oil	1010
Chemical Industry (incl. Pharmaceutical Industry)	460
Food and Beverage Industry	340
Mechanical Engineering/Plant Engineering & Construction	300
Steel/Metal Production	200
Aerospace	150

Source: Nefiodow and Nefiodow 2014 based on 'The Fortune Global 5-Hundred' in *Fortune Magazine* from August, 3, 1998: F-15-F-26.

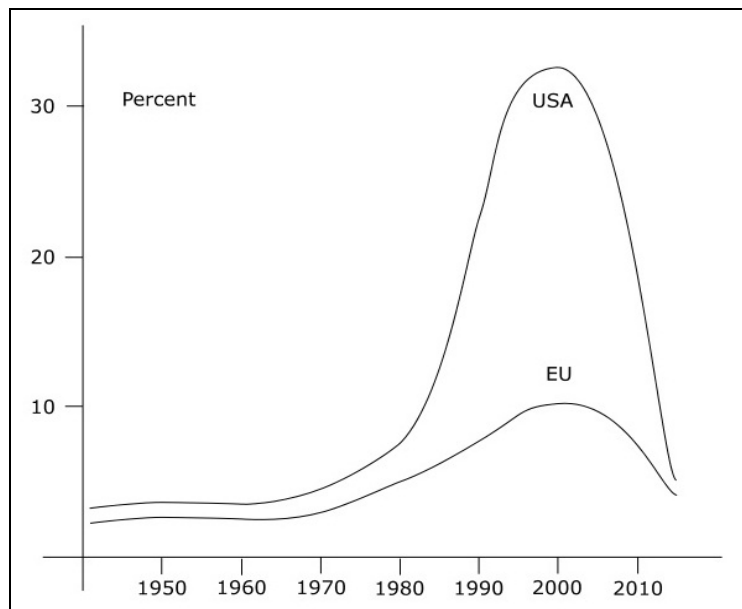


Fig. 3. Contribution of information technology industry to GNP growth including revenues for telecommunication services

Note: Average values are taken during 3–5 year periods. Value added creation was calculated at 50 % of IT revenue.

Source: Nefiodow and Nefiodow 2014.

The leading industries affect the economic system like a locomotive affects a train: they put all wagons of the train in motion. Joseph Schumpeter (1961) called this phenomenon ‘the Bandwagon Effect’. If we stay with the image of a train, the individual wagons represent the sectors of the economy, which benefited from the basic innovation and its leading industries.

The *value chain* is made up of the leading industry and all other sectors that benefit from the basic innovation. Whereas the basic innovation triggers the Kondratieff cycle, the value chain is its actual carrier. This can be illustrated by the example of the fourth Kondratieff (Fig. 4). The car was the basic innovation, the automobile and petrochemical industry sectors were the leading industries and the value chain was made up of the leading industries and all other industrial sectors that benefited directly or indirectly from the automobile: This included highway, bridge and road construction companies, steel and tire manufacturers, manufacturers of fuel power stations and gas-fired power plants as well as countless suppliers of metal, electric, electronic and plastic parts. Numerous companies and service sectors were also a part of the value chain: gas

stations, automobile associations, mass tourism, car dealers, transport companies, banks, insurance companies and the leisure industry. All of these participants built a global network of suppliers, customers, retailers and users, which created millions of new jobs. Every fifth job in the USA and every seventh job in Germany became dependent on the car during the fourth Kondratieff.

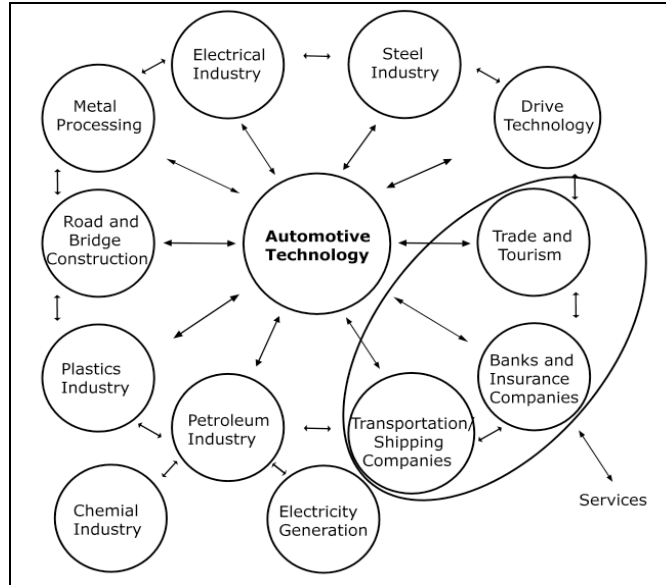


Fig. 4. Value chain of the 4th Kondratieff (this list is not exhaustive)

Source: Nefiodow and Nefiodow 2014.

The value chain of the fifth Kondratieff is illustrated in Fig. 5. When we add the contributions to growth of the value chain including information services such as education, business consulting services, media, advertising, *etc.*, whose development during the fifth Kondratieff was significantly determined by information technology, then the fifth Kondratieff determined more than 70 per cent of U.S. growth during the 1990s.

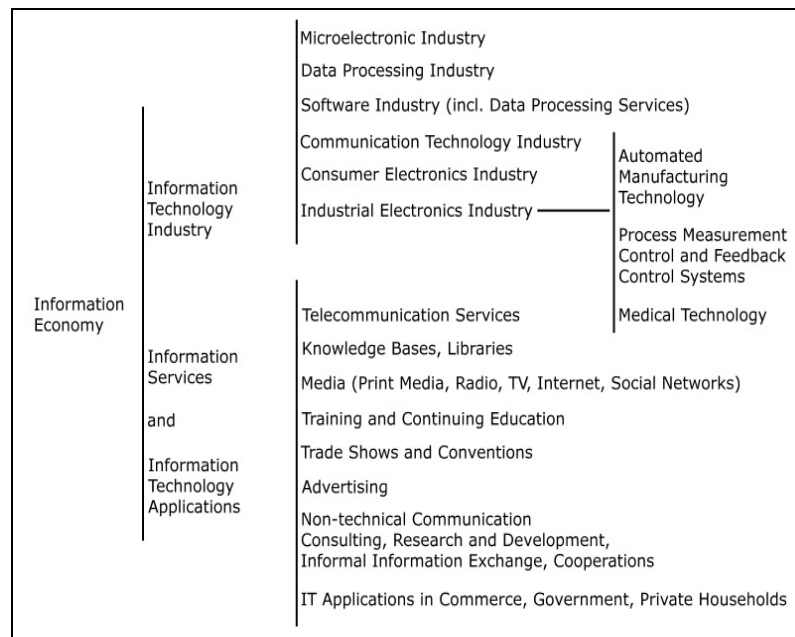


Fig. 5. The value chain of the fifth Kondratieff

Source: Nefiodow and Nefiodow 2014.

Criterion 3. The third criterion pertains to society. The value chain that is caused by the basic innovation leads to a far-reaching reorganization of society.

Observance of this criterion is being checked by determining the diffusion of the basic innovation in society (see Nefiodow and Nefiodow 2014: Appendix 5):

- A brand-new infrastructure develops thanks to the basic innovation. Examples: water routes in the first Kondratieff for coal transportation; the railroad network during the second Kondratieff; connecting society to electrical networks in the third Kondratieff; road and highway networks during the fourth Kondratieff; the telecommunications network of the fifth Kondratieff.

- Thanks to the basic innovation, more efficient work as well as management that is more efficient and organizational concepts are possible in companies.

- In the field of education, it creates new occupations, new areas of expertise, learning contents and studying techniques.

- To ensure controlled handling of the basic innovation, new legal controls have to be created (e.g., data protection acts during the fifth Kondratieff).

- At the stock exchange, the basic innovation guides capital investments to those companies that have specialized in its production and application.

– New forms of leisure, communication and entertainment emerge from the basic innovation.

Criterion 4. The fourth criterion pertains to the *life cycle*. The basic innovation and its leading industry must average a 40 to 60 year life cycle.

The innovation life cycle can be described by the S-curve. The S-curve is determined for instance by accumulating the quantity of the basic innovation (e.g., the number of registered cars in a country) or the value added of the information technology industry and illustrating it over time (Fig. 6). During the life cycle, the basic innovations and leading industries display an above average growth.

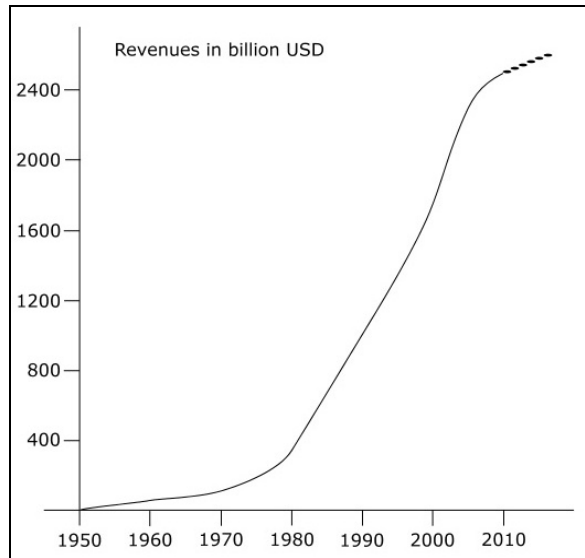


Fig. 6. The life cycle of the information technology industry in the fifth Kondratieff

Source: Nefiodow and Nefiodow 2014.

The 40–60 year duration of a Kondratieff cycle only applies to the pioneers. Latecomers like China or Brazil were able to catch up with the previous Kondratieff cycles in a shorter amount of time, because they utilized the experiences of leading countries through cooperative efforts.

We can remove each innovation that progressively develops for less or longer than 40–60 years for identifying a Kondratieff cycle. Criterion 4 explains why environmental protection for instance is not a basic innovation of the sixth Kondratieff. You can date the birth of modern environmental industry back to the year 1972 when the Club of Rome's famous report *On the Limits of*

Growth was published. Since then, this industry sector has grown above average and there are no discernible growth limits. The life cycle of environmental industry is likely to be far beyond 60 years and is therefore eliminated as a basic innovation of the sixth Kondratieff. That said, environmentalism delivers important contributions to the sixth Kondratieff, in particular as it pertains to ecological health. Although it is not a basic innovation, it is an important part of the holistic health value chain.

These four criteria are sufficient to identify a Kondratieff cycle. To be able to *predict* a new Kondratieff cycle however, you need to add a fifth criterion.

Criterion 5. The barriers of the new Kondratieff cycle.

At the end of a Kondratieff cycle, the previous growth pattern has been mostly exhausted. Before you begin to search for the new basic innovation, you need to first identify the primary growth barriers that conflict with a Kondratieff cycle's development. After all, of all the potential innovations, only those that reduce the barriers the most can be classified as basic innovations. Those barriers can be adherence to outworn concepts, a lack of willingness to innovate, fear of the future, lack of infrastructure, *etc.*

The recession at the end of the first Kondratieff for instance occurred, because companies back then were confronted with a growth barrier. Regional market opportunities had exhausted during the course of the first Kondratieff and transportation costs back then did not allow expansion on a grander scale. High transportation costs were the barrier to the second Kondratieff. This problem was solved with the introduction of the railroad. It cut costs by a factor of 200 and now companies were able to get into mass production, reduce piece costs and export to larger areas.

The growth barrier of the fifth Kondratieff was the lack of a highly productive information processing technology. The number of information and service professions had steadily increased during the fourth Kondratieff, but the technology that was available at the time – the phone, the telegraph, teleprinter and typewriter – was not efficient enough. This barrier was overcome with the invention of the computer.

What growth barriers are we facing today? What impedes sustainable economic growth today in Europe, Japan and the USA?

Every Kondratieff cycle faces its own barrier. Based on our analyses, there are two main barriers when it comes to the sixth Kondratieff; we call the first one the entropic sector.

Barrier No. 1: Worldwide social entropy

Entropy is a term taken from physics that describes the disorder of a physical system. Here the term is used to demonstrate the global social disorder.

Let us take Germany as an example: every fourth German cheats his/her insurance, eight million times per year things get stolen in retail, every fourth fire that costs millions traces back to sabotage; by now every fourth company has fallen victim to cyber crimes, illicit work in 2010 is estimated at 360 billion

euros – that is 15 percent of the gross domestic product. Harassment at work is spreading and costs the German economy 15 billion euros each year. Forty percent of marriages are failing. One quarter of scientific publications is based on manipulated data. This list could go on and on.

Let us take the USA as an example. Statistically speaking, every fifth male American of working age is a criminal. Fourteen percent of adults are considered severely mentally ill and about 50 percent of all marriages end up in divorce. Every fourth American student is being bullied; at least 160,000 children skip school every day for fear of being bullied and 280,000 students are being physically attacked in high schools each month. Almost every tenth adolescent person smokes marijuana; many of them regularly have a joint. Every third U.S. scientist cheats in his/her publications. The national debt has steadily increased for years and is higher than the gross domestic product. Social inequality broke a record in 2009. The net income of the top one percent of income earners increased from 1979 until 2009 by 277 percent; the net income of the poorest fifth, however, only increased by 18 percent to where 0.1 percent of high-income earners made more money than the 120 million people on the bottom. This list could go on and on.

Athletics is also not spared from this increasing disorder. Discoveries of doping cases, referee bribery, manipulations of sporting events and corrupt sports officials are on the agenda every day. During their lifetime, up to 70 percent of women all over the world become victims of physical, psychological or sexual violence. By their own account, every fourth man in Asia raped their partner or another woman at least once. Piracy on the world's oceans is increasing; patent protection and copyrights are systematically being ignored or evaded. Cyber crime is growing by double-digits, computer virus attacks and counterattacks are increasing and have led to a new type of warfare, so-called cyber warfare between countries and institutions. Today, every business and every government can be heavily disrupted or even paralyzed (as the example of the cyber attacks in Estonia in 2007 has shown). This list could also go on and on.

Disorder has become a worldwide mega problem and a mega market. Global money laundering has increased twentyfold from 1990 until 2009 and had almost reached US \$2,000 billion. Corruption and bribery are at a record high all over the world and in 2009 caused at least five percent of all economic costs. The large banks manipulate interest rates (*e.g.*, Libor and Euribor rates) for pure profits interests at the expense of the general public. Millions of people all over the world work for illegal and criminal organizations.

In the following section, the global disorder is conceptualized as an *entropic sector*. If we add up the damages, losses and costs that accumulate every year in this sector, we get an amount of at least US \$14,000 billion for the year 2006 (Nefiodow and Nefiodow 2014). That was more than the United States gross national product. Based on our own calculations, global entropy has increased by at least 25 percent between 2006 and 2013.

The entropic sector plays a key role in the sixth Kondratieff, because the enormous losses, damages and costs that incur year after year in this instance have turned this into the most significant barrier for the economic and social development. This means that the first barrier is not a technological problem, not a problem of energy, but rather an ethical one. We are faced with a similar situation to the one at the beginning of the second Kondratieff, where enormous unfair social structures – lack of rights, extreme impoverishment and worker exploitation – had seriously put the existence of the free market economy at risk. Those countries that introduced social and political innovations just in time (*e.g.*, global health insurance coverage, disability and pension insurance as well as universal male or manhood suffrage) were able to reduce social disturbances and barriers and thus prevent revolutionary upheavals and enable the second Kondratieff to fully develop.

This ethical barrier presented by the entropic sector can also be viewed from a different perspective. Ethical deficits can be seen as health deficits. This becomes apparent if you draw a comparison with the behavior of healthy people. A psychologically healthy person does not cheat and does not rob other people's houses. A mentally healthy person has a good perception of reality, does not use drugs and cannot be bought. A socially healthy person has a sense of community, advocates well-being of all people and does not harass others. A spiritually healthy person does not lie, has a structured and trusting relationship with God, strives for reconciliation, truth and peace and does not spread hatred and violence. Inner disturbances and diseases and the social misconduct caused by them are the deeper reasons for global entropy (see Fig. 7).

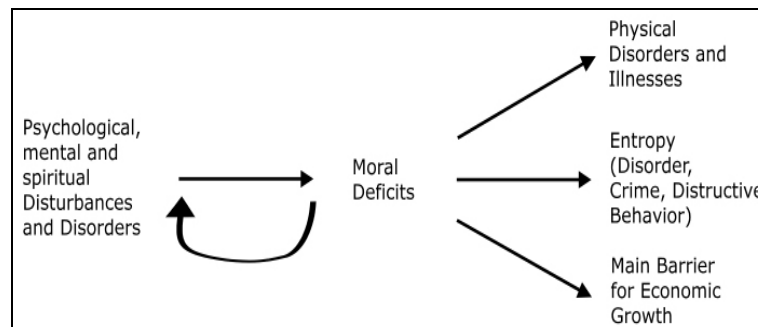


Fig. 7. Causes of global entropy

Source: Nefiodow and Nefiodow 2014.

Barrier No. 2: The traditional health care system

Besides entropy, the traditional health care system is the second main barrier to the sixth Kondratieff (Fig. 8). It includes the pharmaceutical industry, medical technology and academic medicine with physicians, hospitals, pharmacies, health insurance companies, *etc.*

Over the past two centuries, the traditional health care sector made tremendous progress. Many diseases that were considered incurable or fatal in the past can now be effectively treated. Today acute medical care and surgery offer life-saving help even in extreme cases, which is something that was barely considered possible in the past. The history of medicine over the past two centuries was a real success story.

But this success story is about to end. Since the late 20th century, the new medical advances are no longer sufficient to adequately deal with the dynamics and complexity of modern life and its high demands on the physical, emotional and mental strength of human beings. Between 1980 and 2010, the global number of breast cancer incidence rates has doubled and, according to estimates by the United Nations, cancer rates in general are going to more than double during the 2000–2030 period. According to projections by the World Health Organization (WHO), depression is globally going to be the second most common cause of not being able to work and premature mortality by 2020. The increasing number of diseases is also reflected in spending. In 1965, health care spending as a percentage of the U.S. gross domestic product was 5.9 percent; in 2012, it had increased to 17.2 percent (US \$2.8 trillion).

Demographic development is not the only cause for this trend. Young and middle-aged people are also getting sick more often than before. Between 2000 and 2010, the number of mentally ill students in Germany has increased by 20 percent and adolescents and young adults under the age of 25 are among the group with the largest increase in depression. In 2000, every fourth adolescent in Europe suffered from allergies; in 2010, it increased to every third person. Every tenth European between the ages of 45 and 54 regularly takes antidepressants. In the USA, type 2 diabetes has risen tenfold in middle-aged adults during the past 20 years.

The traditional health care system

- Medical technology.
 - Pharmaceutical industry.
 - Health services.
(Doctors, non-medical practitioners, hospitals, health insurance companies, health insurance funds, pharmacists, public health services, medical care facilities.)
 - Health spas/sanatoriums.
 - Company health services.
Health as a competitive factor, training and continuing education (*e.g.*, in people skills), human resource development, health management.
 - Other (health-related).
Skilled trades (*e.g.*, for orthopedic products), sporting goods and sports facilities, health publications, medical EDP, *etc.*
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Fig. 8. Value chain of the traditional health care sector

Source: Nefiodow and Nefiodow 2014.

Pharmaceutical drugs are among the biggest shortfalls of the traditional health care sector. Most of them do not cure the disease; they only suppress its symptoms. What is more, drugs often remain ineffective, because their effectiveness has not been tested before the patient takes them. Migraine medications, for instance, only work for 50 percent of all patients, antidepressants for 40 percent, drugs to treat Alzheimer's disease for 30 percent and cancer therapeutic agents work for 20 percent of all patients at best.

Unwanted side effects are another downside. According to a study by the University of Toronto, using drugs as prescribed is the fourth leading cause of death in the United States.

What we call the traditional health care system today is in fact not a health care system at all. The system structures are not geared towards healing, but mainly towards the treatment of physical diseases. The correct label would be disease care system, since more than 95 percent of expenditures go towards the research, diagnosis, treatment, administration and management of diseases. And this disease care system costs more and more money. Today every sixth dollar in the United States flows into the traditional health care system. More than US\$ 10,000 billion were spent in this area throughout the world in 2012. Medical technological progress is the key driver of these expenditures. It generates approximately 70 percent of the cost increase (Schneider *et al.* 2014: 107). However, the costs of medical technological advances are not offset by obtained savings, which explains the permanent increase in costs.

In contrast, only limited means are available for prevention, preventive medical checkups and healing. Dementia is an example that shows us the consequences. In 2010, the U.S. federal health insurance programs *Medicare* and *Medicaid* spent approximately 140 billion U.S. dollars to treat dementia; but only 0.5 billion to research its causes (Coy 2012). That is a ratio of 280:1.

The traditional health care sector is important; it will remain important and indispensable. It plays a key role today in the economy and society, but it uses up too many resources at this point while productivity is too *low* (Schneider *et al.* 2014).

How can those two barriers – big losses, expenses and damages of the entropic sector and the high costs and low productivity of the traditional health care system – be overcome? In the past, growth barriers were overcome by developing those basic innovations that were able to make the biggest contribution to reducing the primary growth barriers. And these new basic innovations do exist. The new basic innovations are biotechnology and psychosocial health and they come with an emerging new value chain. This new value chain will be the main carrier of the sixth Kondratieff (Fig. 9).

Biotechnology as a Basic Innovation of the Sixth Kondratieff

In the new value chain, biotechnology satisfies the most important criteria for identifying one of the basic innovations of the sixth Kondratieff cycle. It is not

just a brand-new technology, it answers the question on how the second barrier, the traditional health care sector, can be overcome.

Criterion 1. One first-rate indicator is investments in research and development. How much biotechnology has globally shaped the research scene over the past few decades is evidenced by the fact that from 1999 to 2012 two-thirds of all Nobel Prizes in Medicine were awarded for findings in this area.

Within the research scene, private companies play a decisive role both in their research expenditures and in implementation of findings. Biotechnology companies lead the field. The companies in this industry that are listed on the stock exchange globally invested 20–40 percent of revenues in research and development. Biotechnology also obtained top priority worldwide quite early on when it comes to R&D government aid, not just in the USA, but also in Europe, Japan, the People's Republic of China, Australia and Singapore.

The newly emerging health care sector

- Biotechnology.
- Naturopathic treatments, natural products, all natural foods.
- Complementary/alternative medicine.
Homeopathy, classic acupuncture, electroacupuncture according to Dr. Voll, kinesiology, bioresonance therapy, anthroposophic medicine, magnetotherapy, Dr. Rath's cellular medicine, biofeedback, quantum healing, traditional Chinese medicine, Ayurvedic medicine, Reiki, *etc.*
- Environmental protection (predominantly).
- Agriculture, diet, food.
- Wellness/fitness, tourism (health tourism).
- Architecture (healthy living), building and construction industry (healthy building materials), textile industry (allergy free and breathable fabrics and clothing), the senses (color therapies, aromatherapies, music therapies).
- Self-medication and self-care.
Participation of illness costs, rising self-care.
- Workplace health management.
Company health insurance funds, company sponsored fitness programs, cafeterias, welfare centers, health seminars, preventive medical checkups, good health bonus.
- Psychology, psychiatry, psychotherapy, psychosomatic medicine.
- Religion/spirituality.

Fig. 9. Health value chain of the new emerging health care sector

Source: Nefiodow and Nefiodow 2014.

Even in the early phase of the sixth Kondratieff – from 1997–2003 – the life sciences whose core is biotechnology, registered by far the largest increase in the USA with 95.7 percent of R&D government aid. Likewise, at

25.7 billion U.S. dollars, the life sciences were the largest promoted single item in 2003 (Figs 10 and 11).

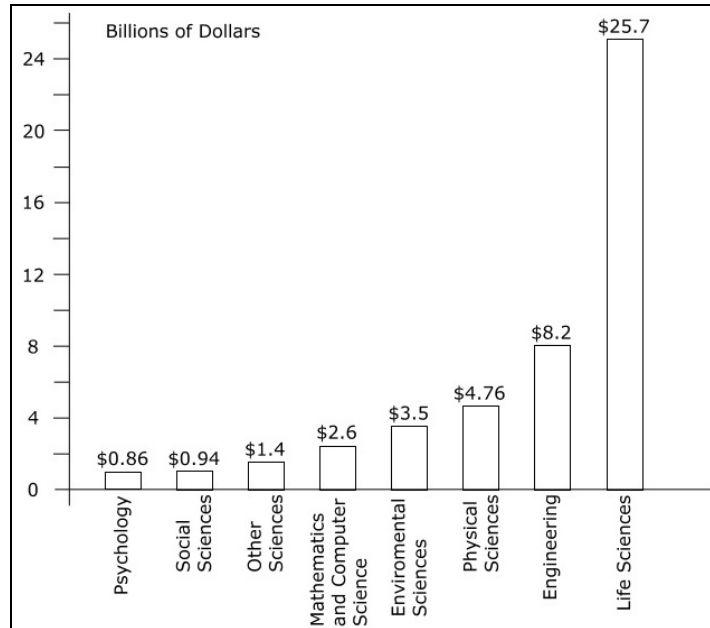


Fig. 10. Research and development expenditures by the U.S. Federal Government.

Source: Carey 2004.

The large R&D expenditures become very noticeable in the health care sector. In 1995, less than ten cancer treatment products were in clinical trials in the USA, most being acutely toxic chemotherapy. In 2005, over four hundred cancer treatment products were in the human testing phase; more than 60 percent of these drugs came from biotechnology companies and most were designed to have minimum side effects.

One impressive example on how biotechnology is able to reduce the second barrier of the sixth Kondratieff and significantly improve productivity of the traditional health care sector is personalized medicine, which emerged in the early 21st century. A little known fact, but nonetheless true, is that pharmaceutical products are completely overrated in their effects today. This is not because the active ingredients are bad. In fact, this is because these active ingredients are used for every patient with the same diagnosis. The genetic makeup of the individual patients is completely disregarded. This results in the fact that 90 percent of drugs, for instance, work only for 30 percent of patients.

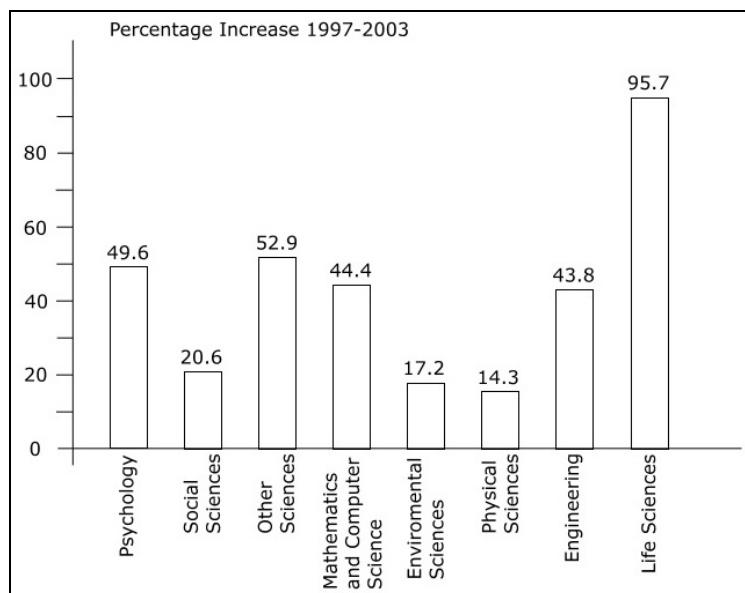


Fig. 11. Research and development expenditures by the U.S. Federal Government.

Source: Carey 2004.

Personalized medicine will make it possible to prescribe drugs in terms of individual effectiveness and tolerance, to avoid medical malpractice, improve the detection and healing of diseases and to reduce the costs for new drug development and costs in the healthcare sector overall. According to American research, personalized medicine could save up to 50 percent in drug spending. Globally this would amount to just under 400 billion U.S. dollars annually. Personalized medicine should put an end to the era of one-size-fits-all drug policies. This is important, because their unwanted side effects are the second most common reason for emergency hospitalizations. Whatever paths personalized medicine will take, the possible improvements are tremendous.

Criterion 2. The basic innovation, its leading industry and its value chain are the most important drivers of economic growth.

The growth of biotechnology from 1980 to 2009 ranged between 14 and 20 percent. Even during the 2000–2002 and 2008–2009 crisis years, the sector grew at double-digit rates. In 2010, genuine, DNA-based biotechnology reached a global turnover of US\$ 120 billion (Nefiodow and Nefiodow 2014). This figure could almost double by 2015.

Among the research-intensive industries, biotechnology has the largest number of startups. In 2008, 4,700 companies worldwide operated in the field of biotechnology, 44 percent of which in North America, 40 percent in Europe and 16 percent in the Asia-Pacific region. Consequently, their contribution in creating brand-new jobs was very important. In 2010, about 500,000 people all over the world were employed in the field of biotechnology.

The economic significance of biotechnology cannot just be deduced from the turnover generated by genuine biotechnology companies. An assessment also needs to consider the revenues, the productivity improvements and the many impulses for new applications, which biotechnology induces in other business sectors, particularly in the industrial sector, in agriculture and nutrition as well as the healthcare sector.

In 2010, one-fifth of the global revenue for the chemical industry is allocated to biotechnological processes and procedures ('white biotechnology'), which equals revenues of *ca.* 250 billion euro. Within the industrial sector, in 2010 the direct and indirect markets in biotechnology reached a volume of 1,500 billion euro. The relative value for pharmaceutical products was 800 billion euro.

The European Union has highlighted the special importance of biotechnology by combining the individual sectors of biotechnology into one mega industry called 'bioeconomy' (this includes the food industry, agriculture and forestry, the fishing industry, the textile, cosmetic and pharmaceutical industries as well as the energy carriers from biomass). In Europe in 2010, this industry employed more than 22 million employees who generated annual sales of 1,700 billion euro (European Union). There are no growth limits detectable over the next few decades.

Criterion 3. The basic innovation and its value chain is the driver of far-reaching changes in society as a whole.

The applications for biotechnology reveal that biotechnological applications are going to significantly change the entire society (Fig. 12): medical science, health, environmental protection, energy production, the chemical industry, agriculture, nutrition, raw material production and biological information processing. Every year new applications are added to this (*e.g.*, the production of artificial plants, microorganisms and brand-new creatures).

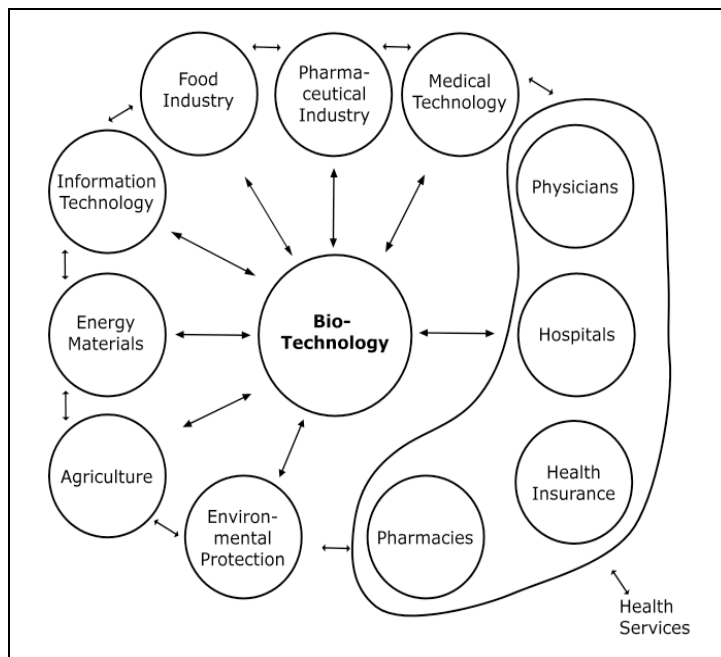


Fig. 12. The biotechnology value chain

Source: Nefiodow and Nefiodow 2014.

Biotechnology can improve the quality of life in many areas of society given a responsible approach. Science can broaden its horizon when it comes to understanding life, which improves the knowledge about human beings and nature. The environment can be protected more effectively and crime fought more successfully with genetic identification methods. Congenital physical disabilities and diseases will be successfully treated over the next 10–20 years. Productivity in the healthcare sector, industrial production, in nutrition and agriculture can be significantly improved, which reduces shortages in the world (hunger, unemployment, raw materials scarcity).

However, a frivolous handling of this highly productive technology can result in considerable damages. Biotechnology could be abused for control purposes and discrimination (*e.g.*, when career and life opportunities would be made contingent on genetic testing). By interfering in hereditary disposition, nature's balancing act can become unbalanced. The respect for Creation can be affected and thus opens the floodgates to manipulations of human beings. And it is also possible that the production of artificial microorganisms, plants and animals could create new diseases and epidemics.

Criterion No. 4. The lifecycle of the basic innovation equates the length of a Kondratieff cycle.

The overall growth cycle cannot be exactly determined during the early phase of a basic innovation. Instead, one has to determine its respective state each year and estimate its further development. From the view of the early 21st century, one can assume that the potential of biotechnology will not be fully developed over the next two decades. At the same time, it is unlikely that the industry will maintain its above-average growth rates over the entire 21st century. Hence, its life cycle almost certainly should be between 40 and 60 years – and thus within the length of a Kondratieff cycle.

Psychosocial Health as a Basic Innovation of the Sixth Kondratieff

Psychosocial health is the second basic innovation of the sixth Kondratieff and the answer to the question on how its biggest barrier – global entropy – can be reduced most efficiently. It also meets the four criteria that are required for identifying a Kondratieff cycle.

Criterion 1. The basic innovation and the innovations based on it in neighboring fields are characterized by above-average innovation dynamics.

Scientific interest, for instance, shows that this criterion is being met. Between 1980 and 1982 approximately one hundred studies on mental and psychosocial health were published in the USA; between 2000 and 2002 it was more than 1,100 (Koenig 2007: 105). This signifies an eleven-fold increase. From 1990 to 2012 it was more than 5,200 (Bonelli and Koenig 2013). This enormous increase in scientific interest speaks for itself.

U.S. government-funded psychology projects also increased above average. With an increase of 49.6 percent between 1997 and 2003, psychology ranks second behind the life sciences among the funded individual disciplines (Fig. 11).

The increasing importance of psychosocial health is also revealed in the increasing research efforts in brain research, neuropsychology and psychiatry. It is indisputable at this point that neural processes and mental and psychological conditions are closely connected in the human brain. Mental disorders and illnesses point to faulty brain activity at the mid range of cell structures. Area 25 of the brain, for example, is seen as the center of the depression circuit; the amygdala causes anxiety and five nerve centers in the midbrain have been identified as the control center of aggression. One can assume that through further findings the relationship between the mind, brain, consciousness, body and social behavior will be better understood and contribute to improved psychosocial health.

The computer provides the opportunity to model mental phenomena, to study them and to develop new therapies. This makes it an important tool for

future psychosocial research. At present, however, many mental and psychosomatic disorders and diseases cannot be treated with modern technologies, because the theoretical understanding is still incomplete. Before computer-aided technologies are able to properly take effect, theoretical and practical research will have to better examine the relationships. Early experiments to treat mental disorders (*e.g.*, phobias) with computer-aided virtual reality technologies have proven successful. People who had fear of small spaces were able to learn how to cope with their fear in virtual rooms. Even though psychoinformatics is still in its infancy, it should experience a rapid development over the course of the sixth Kondratieff.

Criterion 2. The basic innovation, its leading industry and the value chain they trigger will be the main driver of the economy.

To meet this criterion, the basic innovation and its value chain need to penetrate the overall economic structure, to lead it on a solid growth path over several decades and generate large new sales volumes.

And the volumes that can be unleashed by psychosocial health are indeed enormous. As pointed out above (Barrier No. 1), the global losses, damages and costs that are caused by psychological, mental, spiritual, and social disorders and illnesses – social entropy – exceeded US\$ 14,000 billion in 2006. The largest percentage of this is made up of mental and social disorders and illnesses. Ten percent less psychosocially caused entropy would deliver the economy over US\$ 1,400 billion for productive purposes year after year.

An improvement of mental and social health cannot just avoid the enormous losses, damages and costs of entropy; the physical, creative and productive potential of a person is also better mobilized this way. Psychosocial health is a quality of cross-sectional character: it increases productivity in all areas of the society: on the individual, institutional, economic and social level. And since the overall productivity can be increased through psychosocial health, it has an enormous potential for quantitative and qualitative growth.

Criterion 3. The basic innovation is the driver for far-reaching overall social changes.

At first glance, the social importance can be recognized by the high and continuously increasing demand for psychosocial health. This applies to psychotherapeutic, psychological and psychiatric services as well as to radio and television programs, Internet services and publications with psychological, psychiatric and psychotherapeutic content.

A second look shows how much psychology has infiltrated language and awareness and has mentally changed society. The term ‘self-esteem’ for, instance, was not mentioned even once in British newspapers in 1980; in 1990 it appeared 103 times and in 2000 already 3,328 times. In 1993, the word ‘stress’ appeared less than 1,000 times in the British press, but in 2000 more than 24,000 times (Furedi 2004).

Many other terms from the psychology scene have also infiltrated everyday language: repression, projection, sublimation, defense mechanism, depression, neurosis, burnout, psychosis, *etc.* More and more, the mental layers of humans are being specifically addressed, examined, commercialized and burdened. The things that people divulge in public these days in TV talk shows would have still been unthinkable in the mid-20th century. At the beginning of the 21st century, psychological content has developed into a general climate of opinion and in parts into a pseudo-religious doctrine of salvation.

Criterion 4. The life cycle of the basic innovation corresponds with the duration of a Kondratieff cycle (40–60 years).

This criterion cannot be exactly determined during the early phase of a Kondratieff cycle and needs to be assessed and checked year by year instead. From the viewpoint of the early 21st century, we can assume that thanks to increasing networking between brain research, neuropsychology, psychoinformatics, psychiatry and psychotherapies over the next three decades, a noticeable improvement of psychosocial health can be achieved. In light of the increased efforts in research, however, it is unlikely that the industry sector will maintain its leading function throughout the entire 21st century. Hence, this subsequently means that its life cycle should almost certainly be within the length of a Kondratieff cycle.

A New and Holistic Definition of Health

The World Health Organization (WHO) definition of health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. In 1997, the Executive Board of the World Health Organization provided some food for thought with a broader definition of health, '*Health is a dynamic state of complete physical, mental, social and spiritual well-being and not merely the absence of disease or infirmity*' (Khayat n.d.). This is likely the first time a prestigious international institution emphasizes the importance of spirituality for health. This was once again highlighted in the WHO 2005 Bangkok Charter for Health Promotion in a Globalized World, '*Health is one of the fundamental rights of every human being and encompasses mental and spiritual well-being*' (WHO 2009). According to the WHO, terms like disease and health are no longer limited to the body. They are systems concepts. There are also sick souls, social dysfunctions and diseases and sick families, companies and societies.

The Sixth Kondratieff

The new value chain of the sixth Kondratieff also includes other important drivers of growth – aside from the two basic innovations. Naturopathic treatments belong to the new value chain (Fig. 13). They have expanded for many years and will play an important role as a competitive concept for diagnosis,

treatments and healing. Complementary and alternative medicine has expanded also very strongly.

The traditional healthcare system

- Medical technology, pharmaceutical industry.
- Health services.
(Doctors, non-medical practitioners, hospitals, health insurance companies, health insurance funds, pharmacists, public health services.)
- Health spas/sanatoriums.
- Company health services.
Health as a competitive factor, training and continuing education (*e.g.*, in people skills), human resource development, health management.
- Other (health-related).
Skilled trades (*e.g.*, for orthopedic products), sporting goods and sports facilities, health publications, medical EDP, *etc.*

The newly emerging healthcare sector

- Biotechnology.
- Naturopathic treatments, natural products, all natural foods.
- Complementary/alternative medicine.
Homeopathy, classic acupuncture, electroacupuncture according to Dr. Voll, kinesiology, bioresonance therapy, anthroposophic medicine, magnetotherapy, Dr. Rath's cellular medicine, biofeedback, quantum healing, traditional Chinese medicine, Ayurvedic medicine, Reiki, *etc.*
- Environmental protection (predominantly).
- Agriculture, diet, food, wellness/fitness, health tourism.
- Architecture (healthy living), building and construction industry (healthy building materials), textile industry (allergy-free and breathable textiles and clothing), the senses (color therapies, aromatherapies, music therapies).
- Self-medication and self-care.
Participation of illness costs, rising self-care.
- Workplace health management.
Company health insurance funds, company sponsored fitness programs, cafeterias, welfare centers, health seminars, preventive medical checkups, good health bonus.
- Psychology, psychiatry, psychotherapy, psychosomatic medicine.
- Religion/spirituality.

Fig. 13. The health value chain of the sixth Kondratieff

Source: Nefiodow and Nefiodow 2014.

Big portions of environmental protection are a part of this new value chain as well. Why were CFCs, those gases that destroy the ozone layer, banned? Not because we discovered our love for the ozone layer, but because we are facing a skin cancer epidemic with a damaged ozone layer. Why did we put cata-

lytic converters in cars? When you take a closer look, most environmental protection measures only serve the environment at first glance; protecting the health of human beings is the stronger motive. This is why large portions of environmental protection are a part of the health value chain.

The wellness industry, fitness studios and health tourism have expanded strongly. Companies increasingly have come to realize that employee health has become a strategic weapon: SAP for instance, one of the largest software companies offers its 65,000 employees worldwide optional and free genome analysis for them to be able to organize a customized, individual cancer treatment in case of cancer.

In the long run, both value chains are most likely going to merge (Fig. 13). There are already close collaborations between both sectors today. **Health economy** will make up the core of the new value chain, while a network of industry sectors will be around where health plays an important role (*e.g.*, health tourism in the tourism industry or health protection in environmental technology). When you consider the health documents by the WHO, the value chain of the sixth Kondratieff reveals health in a holistic sense: physically, psychologically, mental, social, ecological and spiritual (Fig. 14).

Today the healthcare sector already makes the most important contribution to growth and employment in those countries that respond positively to the sixth Kondratieff. At 3.8 %, the health care sector in Germany, for example, grew almost twice as much between 2006 and 2011 than the overall economy (2.1 %) and the number of wage earners in health care was 5.7 million (2009). When you add those jobs that are indirectly allocated to the health care sector, the number of employees increases to 8.8 million. That amounted to 22 percent of all wage earners (BMW 2013; Ostwald *et al.* 2014). By comparison, the German automotive industry, the showpiece of German industry, only employed about 1 million people (2.5 %). Germany's sizable international reputation over the past years is closely tied to the successful devotion to the sixth Kondratieff.

The fact that the health care sector is a job creator can be also seen in the USA – even though the productivity potential of the health care sector is underdeveloped and the social potential is still being underestimated. In 2001–2012 more than half of all new jobs in the private sector were created in health care (Mandel 2008 and our own calculations). The largest growth barrier for the USA as well as Japan and other countries is the wrong way of handling the health care sector.

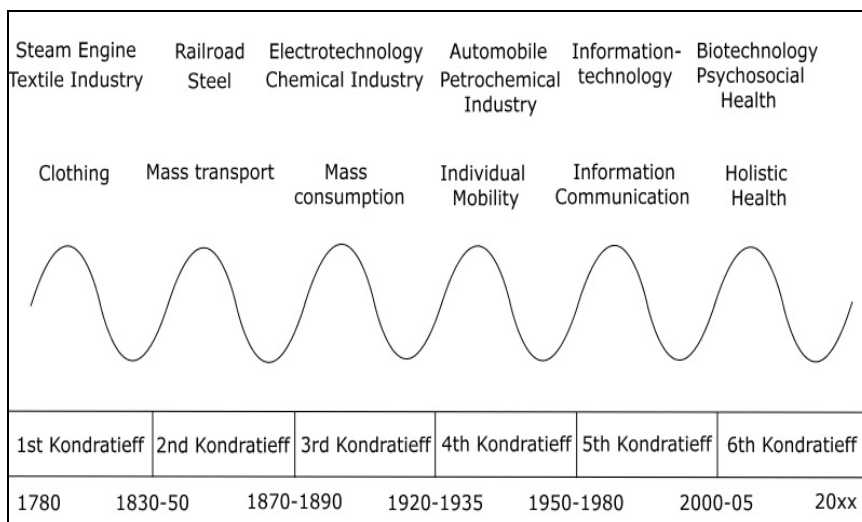


Fig. 14. The six long waves in economic development

Source: Nefiodow and Nefiodow 2014.

Health and Spirituality

In several documents of the WHO faith is mentioned as an integral part of health (WHO 2009). In addition, there is an analysis of 5,200 scientific studies that have been conducted between 1990 and 2010 on the relationship between health and spirituality. The result: in 74 % of cases, there was a positive correlation. In 19 % of cases, the result was neutral, in 5 % negative and in 2 % there was no correlation at all (Bonelli and Koenig 2013). In an extensive study, the World Economic Forum also determined that religious belief could make a vital contribution to preserving individual and social order (World Economic Forum;¹ Ventura and Magnoni 2014). That is why faith plays a key role in the health value chain.

A Look into the Future: Morality as a Competitive Factor

Moral factors frequently do not get high priority in politics and the economy. Yet the financial crisis of 2008–2010, the European debt crisis (2010–2014) and many other crises have shown what devastating consequences poor morals can bring. For a country to be able to renew and to be economically successful, it is not just enough to formally have the structures of democracy, a formally

¹ World Economic Forum's Global Agenda Council on the Role of Faith 2012–2014. URL: <http://www.weforum.org/content/global-agenda-council-role-faith-2012-2014>

free market economy and a due process concept. What is crucial are the morals with which they are being practiced.

The relationship between social responsibility, economy, politics, and morals can be shaped. For centuries, for instance, it was common practice among merchants of Hamburg to seal an agreement with a handshake and its observance was a point of honor. Economy and morals do not have to exclude each other. One large step to strengthen morals on a global basis was the extension and link up of the different international courts of justice and criminal courts. These days, it is no longer as easy as it used to be for public officials and military leaders of the world to totally disregard human rights and get away with it.

Klaus Schwab, the founder of the renowned World Economic Forum, where 1,600 top managers and 40 heads of state participated in 2012 in Davos, Switzerland, stated on the eve of the conference that capitalism in its existing state is no longer the economic model that is able to solve the global issues. Schwab² asks for a new spirit of global social responsibility (Grabitz 2012). His statements are noteworthy, since Schwab is a market economy expert and far from being an opponent of capitalism.

Brazil is one success story of how entropy reduction makes economic progress possible. In the 1980s, the country still ranked among the poor and underdeveloped countries. In the 1990s, thanks to conservative economic policy, it managed to keep hyperinflation in check; the country subsequently introduced active social policy. Yet at first, it did not amount to much. Crime gangs took money away from the poor, which was intended to pay for their children's education, health expenses and to create an independent livelihood. The country then used its armed forces. Three dozens of the worst slums were being occupied and the Mafia driven away. Now the residents were not just able to breathe a sigh of relief, but also invest in their future. From 2001 to 2011, Brazil's middle class grew by 93 percent; it made up almost half of all Brazilians in 2012 (Vèlez-Plickert 2013).

Greece serves as a counterexample. After the end of World War II, the country quickly recovered and worked its way up into the ranks of industrial nations. But then a nationwide network of corruption, political old-boy networks and nepotism developed, which increasingly strangled the economy. Several billion euros from Brussels and European relief programs also trickled away in obscure channels and did not take a turn for the better. As long as corruption was not under control, the country continued to decline. In 2013, Greece lost its status as an industrial nation and was downgraded to emerging market status. The biggest barrier to Greece's growth was and is entropy.

We would like to remind at this point that the free market economy is an economic system that, even though it does not stipulate specific morals for

² See K. Schwab in *Die Welt Newspaper* from January 25, 2012.

market participants, does not work without morals. To be able to work efficiently, the free market economy needs honest business people, incorruptible officials and politicians and unbribable journalists and scientists.

Final Remarks

When the first edition of *The Sixth Kondratieff* was released in 1996, it made a daring prediction. Each year it became more specified and is now supported by studies of renowned institutions (Allianz 2010; BMWi 2013; Ostwald *et al.* 2014). It is not unusual that a new Kondratieff cycle is met with skepticism in the beginning. However, those who identify it early on and consequently develop its potential are able to benefit the most from its dynamics.

A Kondratieff cycle represents a unique historical process. At the innovation level, each Kondratieff cycle has its very own pattern of development, produces new protagonists and satisfies new needs of people. What is so special about this sixth Kondratieff? What makes it so different from the previous cycles?

The sixth Kondratieff is a health-related cycle. This means that for the first time in history, the focus of economic and social development is not on a machine, a chemical process, energy or hardware technology, but rather the human being with his physical, mental, psychological, social, ecological and spiritual needs, problems and potential. We leave the growth patterns of previous Kondratieff cycles behind. Now the human being takes center stage. This is the message of the sixth Kondratieff: the healing of man is the best program for the future.

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