sciendo

STUDIES IN LOGIC, GRAMMAR AND RHETORIC 66 (79) 2021

DOI: 10.2478/slgr-2021-0024

This work is licensed under a Creative Commons Attribution BY 4.0 License (http://creativecommons.org/licenses/by/4.0)

Ewa Okoń-Horodyńska
Jagiellonian University
e-mail: ewa.okon-horodynska@uj.edu.pl
ORCID: 0000-0002-2548-254X

CRISIS AND INNOVATIONS: ARE THEY CONSTRUCTIVE OR DESTRUCTIVE?

Abstract. An interdisciplinary approach was used to analyse multicomplex issues of the Covid-19 crisis, demonstrated also by the Economics of innovation. The Economics of innovation is useful when analysing a unique feedback of megatrends and the emergence of liminal crisis innovations. The purpose of this paper is, in spite of many statements to the contrary, to prove that innovative activity may serve as the key to unlocking a post-crisis economic development. Analyses presented in the paper are based on the Polish and foreign literature on the subject, reports on research conducted in many research centres and the author's own observation at the Social Innovation Council. Three research themes are signalled: 1) the reality of the crisis in the aspect of Covid-19 pandemic and other crises in the literature studies and in practice; 2) innovation as the driving force for recovering from the Covid-19 crisis; 3) Coronavirus support: the activity of the state and social expectations. Conclusions and recommendations contained in this paper are, to a large extent, based on hermeneutics; they also stem from statistical data analyses and own research.

Keywords: crisis, Covid-19, liminal innovations, Coronavirus support.

Introduction

A heartless person could say that the pandemic came at the very last right time to pull a smokescreen to hide all the previously unresolved, accumulated deep, crisis-generating system-based causes: from weaknesses in addressing the causes of the 2008–2009 financial crisis, through the continuously dominant influence of the neo-liberal doctrine of radical posthumanism coupled with simultaneous populism, social inequalities and environmental degradation. This issue is not described by traditional economic theory; therefore, the demand for innovation has arisen in this space as well. Problems of multiple complexity require interdisciplinary, and not fragmentary solutions and the Economics of innovation is such a solution. With its behavioural orientation and the Economics of values, it analyses how and why people change their behaviour and ways of thinking about the future,

whether they are motivated and what motivates them to be creative, prone to take extraordinary risks and make decisions about cooperation in creating and using innovations in order to come up with a new composition of limited resources and produce goods and services that may be used in many different ways in the economy and society, leading to the improvement of the quality of life and business. On the basis of the Economics of innovation with its multidimensional toolkit – the Quintuple Helix innovation model (Carayannis, Barth, Campbell, 2012), the Covid-19 crisis can be analysed with its unique coupling of megatrends and the emergence of liminal crisis innovations. It is claimed that opening of the society and the economy to the potential of diversified, flexible but also dynamic crisis activity that doesn't follow the existing patterns becomes the necessary condition for remaining capable of meeting the requirement of sustainable development after the crisis. Following and analysing the thematic bibliography determines a specific research field, a source of verification and anticipation of future crises-alleviating solutions, which will probably be reflected in theory. Despite many statements to the contrary, the purpose of this paper is to prove that innovative activity may serve as the key to unlocking a post-crisis economic development. The analyses presented in the paper are based on the Polish and foreign literature on the subject, reports on research conducted in many research centres and the author's own observation at the Social Innovation Council. Opinion and conclusions contained in the paper are largely based on hermeneutics; they are also rooted in the analysis of the statistical data and own research. The following research lines are signalled in the paper: 1) the reality of the crisis in the aspect of Covid-19 pandemic and other crises in the literature studies and in practice; 2) innovation as the driving force of the recovery from the Covid-19 crisis; 3) Coronavirus support: the activity of the state and social expectations.

1. The reality of the crisis in the light of the Covid-19 pandemic and other crises in literature studies and practice

According to Web of Science, the unprecedented number of publications published from 2019 to 2021 analysing the innovation – Covid-19 relationship reached 56%, while 44% of the reports covered the global financial crisis (GFC), Covid-19 and innovation, suggesting three lines of analyses: 1) innovation as the cause of economic crises, 2) the specificity of the financial crisis with regard to innovation, and 3) innovation and the potential of overcoming the Covid-19 crisis. While the first two segments have been

already reflected in theory, the third one can operate primarily based on the experience of socio-economic practice. Due to the volume limitations of the study, the analysis of the abundant literature covers some selected links. The importance of innovation in the society and the theoretical justification for it dates back to the 18th century if not to an earlier period, when the classics of economics saw the benefits of human curiosity, opportunities for innovation and improving work in various ways (Smith, 1904), lowering production costs, but also the prices of products made with precision (Say, 1855), the increase in the efficiency of foreign trade (Mill, 1874), while the successors, noticing some negatives, such as the degradation of humanity and inequality in the use of innovation (Marx, 1906), continued the positive image of the role of inventions and innovations as amenities in everyday life and work (e.g. Marshall 1920; Veblen 1994; Kalecki 1986). But it was J. Schumpeter, who introduced innovations to economic theory (1934), considered the first theorist to recognise innovation as the source of crises. According to Schumpeter, a "healthy" economy was not the one that is in equilibrium but the economy is constantly disrupted by technological innovations, at all times representing another industry sector (Schumpeter, 1994, p. 82), creating a cycle that changes the operational conditions from destructive conditions to creative innovation moving in waves and back. Recognising innovation as the root cause of crises did not mean plunging the economy into chaos. After the negative phase, new opportunities emerge to achieve the effectiveness of the upcoming economic growth (Solow, 1999), fuelling economic growth. This regularity has been efficiently used by researchers interpreting the impact of creativity in different ways, innovation, changes in people's behaviour, their competencies, technological changes, patenting knowledge, overinvestment, R&D, institutions or the entire National Innovation System (NIS) for economic growth (including Swan 1956; Arrow 1962; Lucas 1988; Ayers, 1989; Romer 1990; Drucker, 1992; Tylecote, 1994; Okoń-Horodyńska 1998; Asteriou & Agiomirgianakis 2001; Freeman & Louçã, 2001; Perez, 2002; Aschhoff & Sofka, 2009; Šmihula, 2009; Piech 2009;). The approach of Kondratiev (1928) is similar to that of Schumpeter's, linking economic breakthroughs with a technological leap (caused, e.g. by some discovery, invention, production method) or its continuators (Korotayev, Zinkina & Bogevolnov, 2011). Therefore, innovations may cause a crisis characterised by reduced efficiency in applying the existing and new solutions. These two main streams of non-monetary causes of the crisis constantly inspire either modification of the directions and develop new research or too far-reaching criticism (Rothbard 1984), even pointing to the anti-cyclical nature of innovation (Filippetti & Archibugi, 2011).

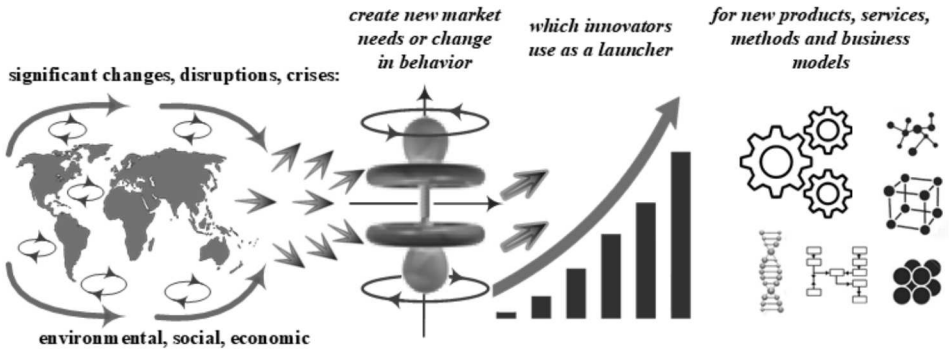
While crises inspired by technological innovations created new opportunities for economic growth at the same time, the three-dimensional (i.e. banking, currency and debt) GFC of 2007–2010 significantly eroded confidence in the positive role of innovation. The theoretically pro-growth significance of financial innovations became pro-cyclical in practice (Minsky, 2008). The chuckle of history is that a peculiar "explosion" of financial innovations, unfortunately only incremental and even quasi-innovations was caused by to some ground-breaking changes in technology in telecommunications and data processing. Innovations in the banking sector, including securitisation, collateralisation, the issue of insurance instruments or structured instruments (Fabozzi & Goodman, 2008; Ghosh, 2008; IMF, 2009; Blanchard, 2009), have become the direct cause of one of the largest speculative bubbles and the American subprime crisis, and through the so-called contagion effect contributed to the severe instability of the banking sector on a global scale. Similarly, financial innovations specific for the period, included many new formulas deliberately avoiding interventions in the financial sector by regulators (Nawrot, 2009; Claessens & Kose, 2013). The GFC is associated with permanent declines in industrial production, investment and productivity, and this applies to both companies (Ahn, Duval & Sever, 2018), industries (Dell'Ariccia, Detragiache & Rajan 2008; Kroszner, Leaven & Klingebiel, 2007) and the macroeconomic scale (Cerra & Saxena, 2017; Kołodko, 2020). As it was, the GFC caused a reduction of the external R&D financing channel, patent and innovation financing by blocking long-term corporate investments, hindering the return of economic activity to the original path of growth (Cerra & Saxena, 2008, 2017; Furceri & Zdzienicka, 2011; Reinhart & Rogoff, 2009; Teulings & Zubanov, 2014). In the process of restricting the external financing of innovations in the crisis, an actual reallocation of bank loans from innovative to non-innovative companies was observed because of excessive risk coming with innovative activity (Hall & Lerner 2010; OECD, 2012; Benoliel & Gishboliner, 2015; Markatou & Vetsikas, 2015; Nanda & Nicholas, 2014; Aghion, Askenazy, Berman, Cette, & Eymard, 2012; de Ridder, 2019; Peia, 2019). A study of patent activity and its effects conducted in 32 OECD countries (Hardy & Sever, 2020), taking into account data from 52 financial crises in the years 1976–2006 (Laeven & Valencia, 2018), showed that as a result of the GFC, the patent activity of a given country drops in 4 years after the crisis, by an average of (– 2.6%), while in crisis-free periods, it goes up by 0.6% on average over the same period (Hardy & Sever, 2020, p. 3). Industries more dependent on external financing (e.g. in 75%) recorded more significant drops in their patent activity (3–5 pp) than the industries with lower

dependencies (Hardy & Sever, 2020, p. 4). However, in both cases, the financing channel did not positively impact the quality of patent applications, so financial constraints do not eliminate lower quality innovations. The position of about 40 researchers preparing the Hardy & Sever report (2020), while mostly stigmatising the effects of the GFC on innovation, is also not free from fierce opponents. In turn, they prove that, although in 37 leading OECD economies the global GDP decline in 2008–2009 was below 2%, in Europe (EU-28), the decline of 2.1% was reported, but 2010 saw a bounce back to the level of 2008 and, in the EU they were even by 1.45% above the result for 2008; (EBM, 2020, p. 65). Global R&D investment in 2009 went down by as little as 1.13% compared to 2008, to return to pre-GFC size as early as 2010. The number of patent applications in Europe fell by 5.7% in 2009 compared to 2008 but increased by 7.6% in 2010. There are also many new types of innovation (including the breakthrough iPS technology that enables cell therapy, OECD, 2012). The GPF did not stop the emergence of innovative companies, for example, according to the 2010 Dow Jones Industrial Index, 18 out of 30 companies were specifically founded in the crisis (Chakravorti, 2010), and in the deepest recession of 2009, the number of startups in the USA was higher than the one during the technological boom of 1999–2000 (KIEA 2014). The data illustrating the investment behaviour of companies during the GFC shows that despite the general fear of investing and the anti-incentive actions of banks, the 50 most innovative companies from the Boston Consulting Group's 2007 list invested in innovation during the crisis, providing shareholders with a 4% higher annual return on investment above the market by 2012 (BCG, 2020). "Expressions of gratitude" for the crisis of 2008, you can hear that it forced a state of mind, accelerating the development of many important innovations (Scott, 2009).

The Covid-19 crisis, in turn, is characterised by complex symptomatology, in its aetiology – it is a multiplied health and economic crisis, in the image – it affects all areas of the functioning of individuals, society and the economy, it is characterised by the lack of panacea and quick solutions, and two contradictory qualities, universality and idiosyncrasy. The universal approach manifests itself in inevitable disorganisation, imbalance, and proposals of anti-crisis solutions already described in economic theory. And idiosyncrasy here means the aspect of uniqueness, peculiarity, individualism, unsuitability of strategies and examples of behaviour known from other crises. This crisis accelerates supply and demand limitations, a combination of features known from the theory and many unknown ones that continue to emerge (Brown, 2019), an institutional disorder without the methodical possibility of anticipating the likely image of the phenomenon in the

future. Therefore, it is one of those that force decision-makers to introduce drastic measures and the society to abandon previous practices and make irreversible changes in their way of life. As the crisis persists, the scale of irrational behaviour towards such phenomena as: 1) knowledge of disease transmission, infection, detection and treatment emerged gradually and continues to evolve; 2) many practices in the field have changed in response to the new remedial measures; 3) the Coronavirus continues to mutate to form variants that spread at different rates in space and time; 4) the solutions applied to mitigate the effects of the crisis are temporary and involve a high risk that cannot be estimated; 5) the so-called good practices are rejected and the existing ways of doings are now questioned; 6) the conditions of the pandemic crisis seem a growing spiral of uncertainty disrupting work organisation methods and work methods, education, culture and, above all, health protection; 7) social expectations exceed the rational capacities to implement them, which often causes institutional chaos and exposes the society to severe social and political conflicts; 8) the common denominator in the conditions of a pandemic crisis for all human activity and the functioning of the economics should be learning, is increasing (Weick, 1988; Hoff, 2021). Thus, the pandemic crisis has made a delineation of time and space by interrupting the known practices and duties and causing a new opening, forcing unconventional, liminal activities that support creativity (Czarniawska & Mazza, 2003). Here, the liminality of action means the blurring and connecting of boundaries, positions, distinctions, categories and concepts that create an unsteady, open and ambiguous state from which "new configurations of ideas, relations, products can arise" (Turner, 1967, p. 97). In the research over pandemics, the use of liminality allows one to investigate how different social actors (e.g. consultants, workers, volunteers, change agents, virus knowledge coordinators, medical services, entrepreneurs, local and central decision-makers, etc. they even create periods of ambiguity to facilitate changes in roles, projects, trajectories, cultures and outcomes, norms and processes, protect the fading away of general expectations, and coordinate new ones, and so how pandemic participants experiment with alternative methods for structuring their activities, which ultimately enables novel ways to organise and act. (Garsten, 1999; Howard-Grenville, Golden-Biddle, Irwin & Mao, 2011; Swan, Scarbrough & Ziebro, 2016). The pandemic crisis allows for the immediate application of new solutions in practice through emerging reconfigurations that solve the problem. Under these conditions, one innovation becomes a starter for another one (Mertens 2018, p. 290). The socio-material acts of past practices have changed significantly. Still, many organisations consider these

Figure 1. Historical pattern for creating crisis innovations



Source: own study.

changes generative, i.e. signifying a continuous process of reducing tensions and creating opportunities to become creative in times of crisis. (Orlikowski & Scott, 2021). Studies on the symptomology of various crisis configurations with innovations in the leading role leave two extreme positions in mind:

1) During a crisis, innovations suffer (Kris Østergaard, 2020)
2) Crises are adrenaline for innovation (McKinsey&Company, 2020)

Both are true, but in the case of Covid-19, attention should be focused on the chances of overcoming the pandemic, since the struggle for survival has always been the most pressing problem of mankind (Keynes, 1963), innovations can be the driving force in mitigating the crisis, and entrepreneurs implementing them today are measuring extraordinary challenges to become the innovation leaders of tomorrow. Historically, crises have set a pattern (Figure 1) for forcing innovation (Sutter, 2009; EBM, 2020) and changing development trends simultaneously.

2. Innovation as the driving forces engaged in overcoming the Covid-19 crisis

A practical approach to dealing with the constraints of the Covid-19 pandemic has been observed in the following research segments:

1. New challenges to innovation
2. Innovation arguably as the driving force in overcoming the Covid-19 crisis
3. Placement of the Covid-19 innovative activity on a new trajectory of the economic growth

The new challenges to innovation result primarily from the multidimensional nature of the Covid-19 crisis, which is a microcosm for future difficulties. The pandemic shows increasing cross-border dynamics, bringing together different problems in many social systems. Here, innovation takes on a new, as yet unexplored, role as a social mechanism for reconciling emerging challenges. Therefore, the development of a pandemic can be seen through the prism of analysing the content of innovative projects and behaviours that respond to the basic human needs of consumers and businesses. Under these new conditions, the structural model of innovation activity and its hidden driving forces can help policymakers and innovators achieve a systemic response to similar crises in the future (Dahlke et al., 2021). Note a change in the **innovation landscape** further to the modification in the practice of the concept of **megatrends**, which include: the style of health, user economy, digital networks, merging offline and online worlds, seamless commerce, urbanisation, data age, distrustful society, artificial intelligence, future work, virtualisation, individualism, Industry 4.0 (Ebersberger B. & Kuckertz, 2021). As Covid-19 innovations are liminal, are born where *megatrends* meet (e.g. before the pandemic, the health style was mainly considered a luxury, after the pandemic outbreak, it expresses satisfaction of basic needs). Drastic changes in socio-technical regimes have become a challenge, resulting in shortages of resources, the collapse of supply chains, and thus a threat to meeting people's basic needs. These gaps were filled with new ideas, with a diverse set of domains, and the necessity for new typologies of innovation, ranging from the technological of crucial importance to economic, fast and pro-social ones. Achievement of **the potential of high speed**, defined by the reaction time of the innovation to solving the problem, is a challenge to innovation that comes with it; for example, it is a challenge to meet the needs in conditions of isolation. Its achievement aspires to the position of a new indicator assessing the innovativeness of the organisation. Due to the priority of practicality in minimising the effects of the pandemic, it is important what global innovators agree that only innovations can solve the problems of the Covid-19 crisis. (Gates, 2020). A package of 8 practical principles of innovation, i.e. **A ROAD MAP** to navigate the multidimensional Covid-19 crisis, is worth considering here. It contains the following determinants: Aspiration; Selection; Discovering; Evolving, Expanding; Acceleration; Scaling; Mobilisation, and the ability and speed of implementation of these determinants is also a measure of the organisation's innovativeness in a crisis (McKinsey&Company, 2020). By identifying the system of human needs and incorporating this perspective into the

strategy of response and decision-making according to the indicated determinants, it is possible to build a crisis management system adequate to the challenges and prevent significant social damage. (Ryan et al. 2020). Research shows that large, well-established organisations have a relative innovation advantage in times of crisis. (BCG, 2020; Archibugi, Filippetti & Frenz 2013; McKinsey& Company 2020; EPO 2020). Larger companies have a considerable pool of resources, industrial property, a more balanced risk profile owing to diversification and, consequently, a greater ability to finance larger companies have a significant pool of resources, industrial property, a more balanced risk profile due to diversification and, consequently, a greater ability to finance investments from their own flows which creates more opportunities for the development of innovation, with the obstruction of the external channel of financing innovation – investments from own cash flows, which increases the chances of the development of innovation, with the obstruction of the external channel of financing innovation. The pandemic crisis has refreshed cooperation between research institutes, universities and large companies. This cooperation may take unconventional forms thanks to which it constitutes the so-called sprint in designing, finding new methods, products and processes, and business models serving the needs of consumers and business. Those who used to compete on the market also cooperate in the new structures, e.g. pharmaceutical companies – they develop new vaccines and drugs (White Paper, 2020, p. 10 and subseq.), by creating radical innovations that – if not for then activity unlocking Covid-19 crisis, (Fretty, 2020), they would never appear. Startups are an extremely active group in the pandemic – fast, flexible, with small budgets, are open to risk, predatory to new ideas, taking advantage of the openness of the market caused by the pandemic, have become the brave and fastest actor ineffective logic and reducing self-referentiality (Ebersberger & Kuckertz, 2021; Technology Pioneers 2020).

Thus, many researchers and practitioners consider the Covid-19 crisis the pinnacle for the enterprises wishing to protects the lives and livelihoods of communities and industries around the world through new ideas and actions (Dahlke et al., 2021). E.g.:

– BCG research (2020) on a sample of 1,200 managers shows that 65% of corporate leaders identified innovation as one of the three highest management priorities, 45% committed their forces and resources to innovation, unfortunately, another 20% did not make such decisions; but as many as 90% of companies have launched digital channels as a new way of interacting with customers;

- McKinsey&Company's study (2020) on a sample of 2,000 organisations from different sector show that 90% of companies believe that the Covid-19 crisis will fundamentally change the way the business is done over the next 5 years; 21% of companies have the expertise, resources and commitment to continue innovative growth successfully; Over 70% of managers believe that the Covid-19 crisis will be one of the most fantastic opportunities for growth in their industry, as much as the technology industry expects 85% and 79% by the pharmaceutical and medical industries.
- Innovations in remote services – modification of the popular Zoom or Skype, have borne fruit such as new video conferencing possibilities in the area of business, telemedicine, education and remote fitness services (Peloton and Hydrow companies) and the development of social contacts; developed digital streaming of museums, theatres, fairs and fashion shows, and sports competitions; (White Paper, 2020)
- Research by EYParthenon (2021) shows that the 21 largest pharmaceutical companies in the world increased their investments in R&D in 2019 by over 14%, which pays off in the crisis; Bayer EBIT increased in 2020. By 53%, Boehringer Ingelheim's pre-tax profit increased by 31%, Merck reported a 28% improvement in EBIT.
- Ultra-fast innovations arose primarily due to the expansion of the competition from various areas, mainly artificial intelligence (AI), robots, ICT in the sphere of medical products, healthcare, many services and the change of business models (White Paper, 2020)
- In Poland (ALK Report, 2021), studies show that among 100 surveyed companies, 60% of them implemented at least 1 innovation during the pandemic; 27% of the companies have developed an innovation strategy, and 32% believe they do not need one; 93% of companies finance R&D from their own resources; 73% of companies promote innovative attitudes of employees; 50% of companies finance innovations with national subsidies, 38% settle R&D relief, the ability to think creatively declines, the aversion to investments increases, attempts were rarely made to change the business model; the activity of start-ups implementing social innovations is growing (MRIS, 2021)

The emergence of crisis innovations results from a real **sense of urgency**, which pays off in using valid theories, such as the theory of perspectives (Kahneman & Tversky 1979), and the resulting galvanisation of actions leading to the reduction of the fear of a failure or a risk of a "breakdown". The pandemic unites people around one goal to which limited resources are dedicated, captures weak points in the system, makes the organisa-

tion more flexible and overcomes infrastructure gaps, allows for the development of innovations that have not been implemented for years due to bureaucratic reasons (e.g. e-education, teleworking, telemedicine). The temporal of the crisis triggers more effort, and then the idea of a sprint, experimenting, milestones pays off (Amabile & Kramer, 2011). Table 1 shows the key technological innovations of the pandemics and their consequences.

Table 1

Short- and long-term consequences of the leading innovation of COVID-19 crisis

No.	Leading innovation in the pandemic	Short-term consequences (1–18 months)	Long-term consequences (18+ months)
1	3D printing	Fast production of medicinal goods and equipment. A new healthcare concept (arrangement)	3D printing acquisition, facilitating local production Enhanced 3D adoption in the industry, faster prototyping and shorter series. Development from B2b to the B2C market, personal 3D printers
2	Flexible production systems	Urgent adaptation of production processes as needed by the medical sector and the quality of life Transferring some labs and pharma production from China and India to Europe and the USA	Redesigning medical devices and global supply. Chain of supply to many productions, resistant services (agriculture, energy, etc.)
3	Big Data, AI	Rapid development and distribution of new vaccines. The AI and Big Data are used to understand the key of a disease, personalised medical treatment.	Corporations and governments using them for monitoring purposes to prevent outbursts of pandemics in the future. Growing demand for cybersecurity software. A growing offer of business and personal data protection services and tools, cybercrime prevention
4	Medical devices, Internet of medical things	Accelerated incorporation, more devices and functions possible in healthcare (smartphones, smartwatches) for quick communication. Remote diagnostics, telemedicine.	Innovative health in health insurance. Consumers accepting smartwear. Development of virtual fitness clubs and gyms
5	e-learning	Teaching during the pandemic	Replacing in-person by digital courses/classes A growing market share of online programmes competing with offline study programmes The impact of e-learning on the content and pedagogical values of curricula
6	e-*gaming*	Increase in the participation of electronic games tournaments modelled on offline sports	The virtual game as an alternative to offline games (league professionals, stars, highest salaries for merchandising, etc.)

No.	Leading innovation in the pandemic	Short-term consequences (1–18 months)	Long-term consequences (18+ months)
7	Video-conferencing	A substitute of the in-person meeting caused by quarantine	Full-time remote work from home Reduced business travel A growing popularity of the ICT among users with an aversion to technology (e.g. the elderly)
8	*Internet streaming*	Blocking the functions of creative industries, delaying the presentation of new artists and works	A turning point in favour of news consumption and entertainment at home Disappearance of traditional media (newspapers, television). A growing Internet bandwidth
9	Cashless payments	A decline in cash-induced infection rate	Developing online non-cash systems Probable dominance of the mobile payment method
10	E-commerce and home delivery	Increase in e-commerce demand in all countries affected by the pandemic	Increase in the e-commerce market share in retail. Increased robotisation in packaging and drones in delivery.
11	Industry 4.0	Data analysis, prompt diagnosis and treatment, monitoring of hospitalised patients, organisation of quarantine	Change of production structures and methods. Humans-machines cooperation. New competencies, new business models.
12	*Blockchain*	Integration of various data, statistical analysis, and transaction registration to verify the performance of the healthcare team. Chains of supply are used to mitigate the pandemics.	Changing the functioning of economic entities and society, new choices in making transactions, using information, generating extraordinary income

Source: Based on Brem & Viardot & Nylund, 2021, pp. 4–5; WHO 2020; CB Insight 2020.

As can be seen from the description of the use of the leading technology innovations in the pandemic crisis, it is very likely that they will be activated after the pandemic. For example, it is estimated that the digital transformation was completed in 2 months instead of the anticipated two years (Sparato 2020). The results of estimating the strength of the impact of the logic of technological innovations implemented during the Covid-19 crisis on society are presented in the descriptive formula in Table 2).

Table 2

Impact of technology development during the Covid-19 crisis on the society

No.	Development of technology innovation	Logic of innovation	Social impact
1	Respirators, vaccines	Time to market	Preparedness for a crisis and its consequences
2	AI, fans	Liminal innovations	Innovations in the ecosystem

No.	Development of technology innovation	Logic of innovation	Social impact
3	Respirators, disinfectants	Flexible production systems	CSR
4	AI, robots	Big data	Intellectual property
5	Carrying devices, cashless payments, streaming, e-commerce	Acceptable technologies	Citizen surveillance
6	Videoconferencing, e-learning, e-gaming	Digitalisation	Flexwork methods

Source: Based on: Sampol, 2020; Morse, 2020; WHO 2020; CB Insight 2020; Thornhil 2020.

Being aware of the effects and strength of the impact on society of innovations implemented during Covid-19, it will be possible to assess their usefulness in another crisis.

Placement of an innovative activity on the new trajectory of economic growth is associated with a change in the behaviour of entities, estimating the long-term effects of innovation in the economics and the strength of the impact of the logic of technological innovation on society during the Covid-19 crisis (Table 1 and Table 2). As the life of the phenomenon is too short (short time series), only descriptive assessments are possible so far. The leading changes in behaviour include:

- **Reallocation of resources** towards the future, using the game theory that allows for sound mixing of funds and people according to the possible pool of profits, as a result of which entities, the so-called "better in the full cycle", using the "innovation launcher."
- **Hacking processes** promoting the priority of speed over precision and a focus on results achieved fast and not on processes, which signifies a change in the culture of operation; (White Paper, 2020)
- **Inclusion** in the innovation culture, consisting in mixing "dreamers" – seeders of ideas with "performers" in the innovation process, will allow for reducing its phases (Okoń-Horodyńska et al. 2017)
- Investments in **"audacious ventures"** – as a result of the ability to effectively manage risk, as well as to experiment for the needs of a pandemic (EY Parthenon, 2021)
- Making entrepreneurs aware of the **higher benefits** of investing in R&D in a crisis (prices of resources, services, and specialists' wages are lower, ensuring higher rates of return after the crisis)
- Combining **traditional tasks with leading technologies** (e.g. AI, ToT) and focusing on experts of new ideas, ensuring sharpness in assessing the effects of activities and slimming organisational models

3. Coronavirus Support: activity of the state and social expectations

In 2020, nearly all countries in the world focused on combating the effects of the Covid-19 pandemic. The demand for innovation does not only apply to the protection against the pandemic or existing the economic recovery but also to the entire area of responding to hazards at the national, EU or global level, in the priority areas, including assessment and supervision, communication and public information, management and framework legal issues (PANDEM, 2020). The University of Cambridge estimates, the coronavirus may cost the global economy up to 82 billion USD over five years – that's four times the annual GDP of the USA (WHO, 2020). Long-term monitoring of innovation trends in the world, which is a result of work of researchers from many countries and prepared, among others by PARP (2020), PIE (2020), TATIFE (2020), WEF (2020), allows you to select countries that combine Coronavirus support for entrepreneurial and employment activity with anticipating trends in technological innovations ensuring a high position in the global rankings of innovativeness after the crisis. Although the immediate goal of the intervention is to improve the conditions in the economy in the long term and increase its production capacity, some countries have strategic development goals in mind from the very beginning of their anti-crisis measures. Setting out the development priorities allows for a smoother transition through the successive phases of the crisis and faster implementation of long-term measures. For example, ultra-fast innovations at the beginning of a pandemic should stimulate the development and securing development segments through investments in health, education, science and further innovations. In a crisis, the forced relatively large size of public investments, and their proper organisation may also increase financing innovation in the private sector. The instruments of combining Coronavirus support with development policy in selected countries are presented in Table 3.

Table 3
Coronavirus support combined with developmental priorities – examples

No.	Country	Support and development priorities – a description	SCORING Overtaking/post-crisis versus pre-Covid-19 From (–5) to (+5)
1	AUSTRALIA	free access to patent data, acceleration of the implementation of leading technologies, Job Hub website for a job search in leading sectors, Export Hub Initiative, co-financing of export of leading technologies	+ 3

No.	Country	Support and development priorities – a description	SCORING Overtaking/post-crisis versus pre-Covid-19 From (–5) to (+5)
2	AUSTRIA	research and innovation to fight COVID-EUR 19.26 million, drug research EUR 23 million, digitisation of companies EUR 8 million, digital competencies EUR 4.4 million, digital future for SMEs EUR 4 million, AI Ideas Lab 1.2 million Euro, startups and spin-offs – PHŐNIX	+ 4
3	CHINA	enterprise transformation – digitisation and artificial intelligence, cloud technologies, Big Data, digital economy business models, a digitised ecosystem of the entire industrial chain, platform enterprises, intelligent water-saving technologies, startups and innovation incubators	+ 5
4	CZECH REPUBLIC	Czech Rise Up 2.0 – smart technologies to combat Covid-19, R&D, TREND – industrial research, coupons for Covid-19 innovations,	+ 3
5	DENMARK	Support package – 13% of GDP for the economy to recover from the crisis	+ 3
6	ESTONIA	Knowledge-based Estonia – innovative development 2021–35, digitisation of health data, Enterprise Estonia – innovation for companies, ICT EUR 15 million	+ 2
7	FINLAND	sustainable economics, digital economics and society, green recovery package – green infrastructure investments	+ 5
8	FRANCE	Bpifrance – 90% guarantees for loans (30 thousand companies), innovative startups EUR 2 billion, the automotive industry – EUR 8 billion, R&D for young companies	+ 3
9	SPAIN	Employee layoff ban	– 2
10	IRELAND	Digital School of FOOD – food production, Enterprise Ireland – hiring managers with experience in innovation, a road map to support companies with tremendous growth potential	+ 2
11	ISRAEL	Digital health Lab, Start-Up now innovative enterprise – UR 3 million, development of medical technologies from the USA, Germany, high-tech sector USD 180 million	+ 4
12	JAPAN	investment in renewable energy sources – 24% of energy in 2030, hydrogen economics, electricity almost for free, financing of scientists, "moonshot" 6 goals for health, artificial intelligence robots, EUR 830 million, sustainable food production	+ 5
13	MALAYSIA	digitisation of SMEs, digitisation of rural areas, 20 Coronavirus support tools, tax-deductible costs of modern competence training, digitisation, e-commerce platforms directly from the countryside to the cities, green transformation	+ 4
14	GERMANY	bioeconomics, quantum computing, Q System One, Europe's first quantum computer system EUR 40 million, internationalisation of startups, innovative transport, Kurzarbeitergeld, startup alliances in the energy sector, quick loans for SMEs up to EUR 800 thousand, support for digitisation in transport EUR 102 million. Euro	+ 5

No.	Country	Support and development priorities – a description	SCORING Overtaking/post-crisis versus pre-Covid-19 From (–5) to (+5)
15	NORWAY	NOK 2.1 billion for subsidies for innovation, (doubling), green economics package, tax reduction for innovative business, environmental technologies NOK 750 million, covid package NOK 5 billion, climate and social research NOK 1 billion	+ 4
16	POLAND	7% of GDP of support, Anti-Crisis Platform for Technological Solutions, Incubator for Social Inclusion, STEAM system for education, "Resilient Culture", nearshoring, "Polish Deal."	+ 1
17	USA	public-private partnership for medicine and drugs, rapid testing, crowdfunding innovation, research into leading technologies $ 2 billion, crowdfunding innovation platforms	+ 2
18	SWITZERLAND	9% of GDP for support, SMEs and startups – 100% financing of projects, the "Switzerland Innovation" program, reduction and tax breaks for consumers, "SI Tech4Impact" open cooperation of innovation partners	+ 3
19	SWEDEN	SEK 42 million (E 4.1 million) for 141 innovative startups, SEK 52 million (E 5.1 million) for SMEs, cooperation with Taiwan and Israel in research and innovation projects	+ 4
20	UK	£ 1.25 billion for innovators, innovations COVID-19 £ 84 million: vaccine, drugs and, business innovation in Business Improvement Districts-£ 6.1 million, £ 250 million for Future Fund – startups.	+ 3

Source: Own study based on: PARP (2020), PIE (2020), White Paper (2020), McKinsey&Company (2020), TAFTIE(2020) OECD (2020).

The above-presented overview of selected Coronavirus measures shows the scale and diversity of support for innovation development. Nearly any weal state governments try to mitigate lockdown-related losses, including those caused by the crisis on their national innovation systems. In the first period of the crisis, social actors had mainly demanded expectations, believing that the pandemic crisis, as a rule, was not the result of their actions or their negligence. In its subsequent stages, the response to the crisis of many social actors brought new ideas, ideas, unconventional solutions and finding opportunities for new entrepreneurship with rational state support. The early compendium of technological responses to Covid-19 (White Paper 2020) shows that thanks to the Coronavirus support from the state, the number of solutions that ensure better use and diversified applications of existing and modified technologies in the world has more than tripled. In a crisis, the effectiveness of state aid in the development of innovation turns out to be higher, which is worth using in the interests of the state and society.

Discussion and Conclusions

One does not need any in-depth comparative analyses to prove that the Covid-19 crisis is unprecedented in the history of modern economic systems. Economic policy (fiscal or monetary) tools so far do little to fight the multiple health and socio-economic crises. In their debate, academics and practitioners quite agree on the sense of introducing any short-term measures to overcome the recession, which the world will probably achieve at the end of 2021. Global economy returned to the path of economic growth will be only general and average because also during the next stages of the crisis, some companies, sectors and national economies will see a decline in the value of production and services. Therefore, it is important to avoid succumbing to the illusion in the discussion about the post-Covid situation that the essence of the solutions and the point of reference is only the *reset* and reconstruction of what was. The study presents a lot of evidence that the crisis, such as the Covid-19 pandemic while prompting managers to mitigate losses, creates opportunities, changes the way of thinking and decision-making, and paves the way for innovation in the short term horizon. The "launchpad for innovation", forced by the pandemic, set the priorities in important plans and programs of broadly understood innovative activity in the medium and long term (Table 3). The analysed literature of the Covid-19 period revealed many pathologies in science and innovation policy at all levels of the economics (on a terrifying scale in the EU instruments), which will certainly force changes in the shape and operation of national innovation systems after the pandemic. The cited and own studies have shown the irrationality of reducing R&D spending, limiting investment in innovation (general cost-cutting) or interrupting innovative projects in a crisis because it means an unfavourable competitive position after the economy exits the crisis. In most sectors, the development cycle of new products is longer than the duration of the average recession; therefore, it is not profitable to interrupt already started projects. Investing in innovations in a crisis ensures a rapid increase in the rate of return and, most often, achieving a leading position after recovering from the crisis, many examples of which have been presented. The more so because public investments, especially health investments, recommended across the world (Mazzucato, 2020), are increasing, supporting private investments, reducing the risk scale. The pandemic showed the great importance of industry in the economics, which became a heroin quick response to the health threat, the Covid-19 crisis, accelerated digitisation by several years (in Poland by 5–7 years), brought the advantages of artificial intelligence to the public, and certainly launched

new layers the demand for technological innovation. The conclusions from the studies cited in the study leave no illusions about the emergence of subsequent crises having various causative grounds. It will take building strategic stocks, creating organisational, infrastructural and institutional conditions strictly based on the recommendations of national and world security centres to prepare for them. It requires a surge in R&D expenditure, a change in investment orientation to realise the enormous needs in innovation. In the era of nuclear weapons, it is pointless to invest in the army or repeat the old investment models but invest in education, new competencies, science, culture, in Industry 4.0, in the growth of research and operational staff in the healthcare system. Unnecessarily long chains of supply need to be shortened, as they drive huge losses in a crisis. An attempt to compare various forms of support for innovation in a pandemic (Table 3) has shown that these are random instruments taken from other countries or EU suggestions in many cases. It is worth preparing a universal toolkit model to protect and support innovative activity in crisis conditions. The crisis invention of various social actors is a new source of innovation development. As a result of forced savings caused by the closure of the global economics, huge funds have been accumulated in search of a place to invest; it is worth redirecting them efficiently to the development of innovation. The Covid-19 crisis space is full of opportunities for research on liminal innovations, their specific manifestations in various industries, assessment of the scale of creative and lasting change in a crisis, exploration of the critical process of iterative experimentation and implementation, and maybe even marking the industry trajectory in the future, or the reasons for supporting them. In this thread, in order not to waste valuable results on the development of innovations of the Covid-19 period, it is worth using them to study their impact on the sustainable transformation of consumption, companies and economies, because the megatrend – sustainable development is still on the periphery of the current innovative activity.

REFERENCES

Ahn, J.,Duval, R. & Sever, C. (2018). *Macroeconomic policy, product market competition, and growth: the intangible investment channel*. Mimeo.

Aghion, P., Askenazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit constraints and the cyclicality of R&D investment: evidence from France. *Journal of the European Economic Association*, 10(5), 1001–1024.

ALK Raport (2021, 12 February)), Polski Biznes w czasie pandemii, VRaport badawczy, https://www.kozminski.edu.pl/pl/review/polski-biznes-w-czasie-pandemii-podsumowanie-v-turybadan-listopad-2020-styczen-2021

Amabile, T. & Kramer S. (2011, August). The power of Small Wins in times of panic, *Harvard Business Review*, https://hbr.org/2011/08/the-power-of-small-wins-in-tim.html

Archibugi D.,Filippetti A. & Frenz M. (2013), The impact of the economic crisis on innovation: Evidence from Europe, *Technological Forecasting and Social Change*, Elsevier, 80(7), 1247–1260.

Arrow K. J. (1962), The economic implications of learning by doing, *The Review of Economic Studies*, 29, 155–172.

Aschhoff B. & Sofka W. (2009), Innovation on demand– can public procurement drive market success of innovations, *Research Policy*, 38, 1235–1247.

Asteriou A. & Agiomirgianakis G. M. (2001), Human capital and economic growth: Time series evidence from Greece, *Journal of Policy Modeling*, 23, 481–489.

Ayres R. (1989). *Technological Transformations and Long Waves* (PDF), International Institute for Applied Systems Analysis, Laxenburg, Austria.

BCG (2020, 13 April), Tommorow's Innovation Leaders are made today, https://www.bcg.com/publications/2020/six-moves-for-innovation-during-recovery

Benoliel, D., & Gishboliner, M. (2015). The effect of economic crises on patenting activity across countries. Chicago-Kent *Journal of Intellectual Property*, 14(2).

Blanchard O. (2009, April), The Crisis: basic mechanisms, and appropriate policies, *IMF Working Paper*, WP/09/80, International Monetary Fund, Washington.

Brammer L.M. (1985) *The helping relationship: process and skills*, Prentice Hall: Upper Saddle River, New York.

Brem A. & Viardot E. & Nylund Petra A. (2021), Implications of the coronavirus (COVID-19) outbreak for innovation: Which technologies will improve our lives, *Technology Forecasting & Social Change*, Elsevier, 163, https://doi.org/10.1016/j.techfore.2020.120451

Brown J. (2019), Grypa. Sto lat walki. WUJ, Kraków.

Carayannis, Elias G., Barth, Thorsten D. & Campbell David F. J. (2012): The Quintuple Helix innovation model: Global warming as a challenge and driver for innovation, *Journal of Innovation and Entrepreneurship*, Springer, Heidelberg, 1, 1–12, http://dx.doi.org/10.1186/2192-5372-1-2

CB Insight (2020), *Alphabet's Next Billion-Dollar Business: 10 Industries to Watch*. https://www.cbinsights.com/research/report/industries-disruption-alphabet/

Cerra, V., & Saxena, S. (2008). Growth dynamics: the myth of the economic recovery. *American Economic Review*, 98(1), 439–457.

Cerra, V., & Saxena, S. (2017). Booms, crises, and recoveries: a new paradigm of the business cycle and its policy implications. *IMF Working Paper*, WP/17/250.

Chakravorti B. (2010), Stakeholder Marketing 2.0, *Journal of Public Policy & Marketing*, 29(1), 97–102.

Claessens S., Kose M.A. (2013), Financial Crises: explanations, types, and implications, *IMF Working Paper*, WP/13/28, International Monetary Fund, Washington.

Czarniawska B. & Mazza C. (2003) Consulting as a Liminal Space, *Human Relations*, 56(3), 267–290.

Dell'Ariccia, G., Detragiache, E. & Rajan, R. (2008). The real effect of banking crises. *Journal of Financial Intermediation*, 17(1), 89–112.

de Ridder, M. (2019). Intangibles investment and the persistent effect of financial crises on output. *Cambridge INET Working paper.*

Dahlke J., Bogner K., Becker M., Schlaile M.P., Pyka A. & Ebersberger B. (2021), Crisis-driven innovation and fundamental human needs: A typological framework of rapid-response COVID-19 innovations, *Technological Forecasting & Social Change*, Elsevier, 169(2021)120779.

Diamond D., Dybvig P.H. (1983), Bank runs, deposit insurance, and liquidity, *The Journal of Political Economy*, 91(3), 401–419.

Donatiello D. & Ramella F.(2017), The innovation paradox in Southern Europe. Unexpected performance during the economic crisis, *South European Society and Politics*, 22(2).

Drucker P.F.(1992), *Innowacje i przedsiębiorczość. Praktyka i zasady*, PWE, Warszawa.

EBM (2020), What happens to innovation in a crisis, European Business Magazine, https://europeanbusinessmagazine.com/innovation-and-education/happens-innovations-crisis/

Ebersberger B. & Kuckertz A. (2021), Hop to it! The impact of organization type on innovation response time to the COVID-19 crisis, *Journal of Business Research* 124, 126–135.

EPO (2020), European Patent Office Report 2004–2019, https://ec.europa.eu/eurostat/databrowser/view/sdg_09_40/defauld/table?lang=en)

Erikson E., (1994, 13 May), Psychoanalyst Who Reshaped Views of Human Growth, Dies. The New York Times [on-line]. nytimes.com.

EY Parthenon, (2021), Czy szybkość zmian strategii korporacyjnej twojej organizacji może wyprzedzić Globalną dynamikę zmian? https://www.ey.com/pl_pl/strategy/four-ways-to-rethink-how-you-develop-strategy

Fabozzi Frank J. & Goodman Laurie S. (2008), *Subprime mortgage credit derivatives*, Wiley and Sons Inc., New Jersey.

Filippetti A. & Archibugi D. (2011), Innovation in times of crisis: National systems of innovation, structure and demand. *Research Policy*, 40, p. 179–192.

Freeman, Ch.; Louçã, F. (2001). *As Time Goes By. From the Industrial Revolutions to the Information Revolution.* Oxford: Oxford University Press.

Fretty P. (2020, 25 March), Tale of COVID-19: Crisis Inspiring Innovations, *Industry Week.*

Furceri, D., & Zdzienicka, A. (2011). The real effect of financial crises in the European transition economies. *Economics of Transition*, 19(1), 1–25.

Garsten C. (1999), Betwixt and between: temporary employees as liminal subjects in flexible organizations, *Organization Studies*, 20(4), 601–617.

Gates B. (2020, 30 April), Pandemic I: The first modern pandemic. https://www.gatesnotes.com/Health/Pandemic-Innovation.

Ghosh S. (2008), The composition of government spending and growth: is current or capital spending better?, *Oxford Economic Papers*, 60(3).

Gilliland B. E. & James R. K. (2013), *Crisis intervention strategies*, Brooks/Cole Cengage learning, Boston.

Hall, B., & Lerner, J. (2010). The financing of R&D and innovation. *Handbook of the Economics of Innovation*, 1, 609–639.

Iansiti M. Lakhani K.R., (2020), Przełom, który prowadzi do zderzenia: nowa dynamika konkurencji, *Management Review Polska*, 5(2020).

Hardy B. & Sever C. (2020), Financial crisis and innovation, *BIS Working Papers*, 846, Monetary and Economic Department.

He, H. & Harris, L., (2020), The impact of Covid-19 pandemic on corporate social responsibility and marketing philosophy. *Journal of Business Research*, 116, 176–182. https://doi.org/10.1016/j.jbusres.2020.05.030.

Hoff T. (2021), Covid-19 and the study of professionals and professional work, *Journal of Management Studies*, 58(5), 1395–1399.

Howard-Grenville, J., Golden-Biddle, K., Irwin J. & Mao, J. (2011), Liminality as Cultural Process for Cultural Change, *Organization Science*, 22(2), 522–539.

IMF (2009, April), Global Financial Stability Report. Washington DC.

Kalecki M. (1986), *Teoria dynamiki gospodarczej: rozprawa o cyklicznych i długofalowych zmianach gospodarki kapitalistycznej*, PWN, Warszawa.

KIEA (2014), Kaufman Index of Entrepreneurial Activity 1996–2013, https://www.kauffman.org/wp-content/uploads/2019/12/kiea_2014_report.pdf

Kaufman G.G. (1988), Bank Runs: Causes, Benefits and Costs, *Cato Journal*, 7(3), 559–594.

Keynes J.M. (1963), *Essays in Persuasion,* New York: W.W. Norton & Co., 358–373, original: http://www.econ.yale.edu/smith/econ116a/keynes1.pdf

Kondratiew N.D. (1928), oryg. Большие циклыконъюнктуры. Институт экономики РАНИОН, Москва, (ang. The Long Wave Cycle. NY: Richardson & Snyder. New York, 1984).

Kołodko G. (2020, 20–27 December), Globalizacja może być inna, *Myśl Polska*.

Lucas R.E. (1988), On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22, 3–42.

Laeven, L., & Valencia, F. (2018). Systemic banking crises revisited. *IMF Working Paper*, 18/206.

Korotayev A., Zinkina, J., Bogevolnov, J. (2011). "Kondratieff waves in global invention activity (1900–2008), *Technological Forecasting and Social Change*. 78 (7).

Kroszner, R., Laeven, L. & Klingebiel, D. (2007). Banking crises, financial dependence, and growth. *Journal of Financial Economics*, 84, 187–228.

Kuckertz A., Brandle L., Gaudig A., Hinderer S., Reyes, C.A., Morales, Prochotta A., Steinbrink K. M., Berger Elisabeth S.C. (2020), Startups in times of crisis – A rapid response to the COVID-19 pandemic, *Journal of Business Venturing Insight*, Elsevier, 13(2020) e00169.

Lucas R. E. (1988), On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22, 3–42.

McKinsey & Company (2021), Innovation: Your launchpad out of the COVID-19 crisis, https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/innovation-your-launchpad-out-of-the-covid-19-crisis,

Mertens M.(2018), Liminal innovation practices: questioning three common assumptions in responsible innovation, *Journal of Responsible Innovation*, 5(3), 280–298.

Marshall A. (1920), Industrial Organization, Continued. The Concentration of Specialized Industries in Particular Localities. In Principles of Economics, Macmillan and Co., Ltd., http://www.econlib.org/library/Marshall/marP.html

Marx K. (1906), *A Critique of Political Economy. The Process of Capitalist Production*, t. 2, Charles H. Kerr and Co., Chicago, http://www.econlib.org/library/YPDBooks/Marx/mrxCpB.html

Mazzucato M. (2016), *Przedsiębiorcze państwo*, Heterodox, Warszawa.

Mill J. S. (1874), Of the Laws of Interchange between Nations; and the Distribution of the Gains of Commerce among the Countries of the Commerical World. In Essays on Some Unsettled Questions of Political Economy, Longmans, Green, Readers, and Dyer, London, http://www.econlib.org/library/Mill/mlUQP1.html

Minsky, P.H.(2008), Securitization notes prepared for discussion. The Jerome Levy Economics Institute of Bard College. *Working Paper* 2(2008).

Morse, J.(2020), Ventilator Manufacturers Aren't Impressed By Elon Musk's Offer. Mashable, March. https://mashable.com/article/experts-doubt-tesla-elon-muskmanufacture-ventilators/?europe=true

MRIS (2021), Nabór na innowacje w obszarze włączenia społecznego, rops.krakow.pl

OECD (2012), Innovation in the crisis and beyond. OECD Science, Technology and Industry Outlook.

OECD(2020), Research and Development Statistics https://www.oecd.org/sti/inno/researchanddevelopmentstatisticsrds.htm

Okoń-Horodyńska E. (1998), *Narodowy system innowacji w Polsce*, AE Katowice.

Okoń-Horodyńska E., Wisła, R., Sierotowicz, T. & Zachorowska-Mazurkiewicz, A. (2017), Institutional Surrounding of Innovative Activity – Based on Opinions of Women and Men Engaged in the Process of Innovation, *International Journal of Contemporary Management*, 16(1), 11–35.

Orlikowski W.J. & Scott S.V. (2021), Liminal innovation in practice: Understanding the reconfiguration of digital work in crisis, *Information and Organization*, Elsevier, 31(1).

Østergaard K., (2020, April), How to navigate the Coronavirus Crisis with Innovation in Warp Speed, SingularityU Nordic, https://singularityhub.com/2020/04/17/how-to-navigate-the-coronavirus-crisis-with-innovation-at-warp-speed/

PANDEM (2020), Pandemic Risk and Emergency Management, HORIZON2020 https://cordis.europa.eu/project/id/652868/pl

PARP (2020), *Monitoring trendów w innowacyjności*, Raport 8, Warszawa.

Peia, O. (2019). *Banking crises and investments in innovation.* mimeo.

Perez C. (2002). *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages.* UK: Edward Elgar Publishing Limited.

PIE(2020), Pandemics. Zestaw narzędzi fiskalnych i monetarnych w dobie kryzysów, Warszawa.

Piech K. (2009), *Wiedza i innowacje w rozwoju gospodarczym: w kierunku pomiaru i współczesnej roli państwa*, Instytut Wiedzy i Innowacji, Warszawa.

Reinhart, C., Rogoff, K. (2009). The aftermath of financial crises. *American Economic Review*: Papers and Proceedings, 99(2), 466–472.

Romer P. M. (1990), Endogenous Technological Change, *The Journal of Political Economy*, 98, 71–102.

Rothbard M.N. (1984), The Kondratieff Cycle: Real or Fabricated?, LewRockwell.com, https://www.lewrockwell.com/1970/01/murray-n-rothbard/business-cycles-real-and-fabricated/

Ryan, B.J., Coppola, D., Canyon, D.V., Brickhouse M., & Swienton, R. (2020), COVID-19 community stabilization and sustainability framework: an integration of the Maslow hierarchy of needs and social determinants of health. Soc. Disaster Med. Public Heal. Inc. 1–7. https://doi.org/10.1017/dmp.2020.109.

Sampol, C., (2020, 19 March), Covid-19: Developing High Tech Protective Masks. E-magazine MedicalExpo. http://emag.medicalexpo.com/covid-19-development-of-high-techprotective-masks/.

Say, J. B. (1855), Of the Labour of Mankind, of Nature, and of Machinery Respectively. In C. C. Biddle (ed.), *A Treatise on Political Economy*, Lippincott, Grambo & Co., Philadelphia, http://www.econlib.org/library/Say/sayT7.html

Schumpeter, J. A. (1934), *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*, Oxford University Press, London.

Schumpeter, J. A. (1994), *Capitalism, Socialism and Democracy*, Routledge, London and New York.

Scott, D.A. (2009), After Lehman: How Innovation Thrives in a Crisis, Harvard Business Review, 09/2009, https://hbr.org/2009/09/how-innovation-thrives-icr?referal=03759&cm_vc=rr_item_page.bottom#comment-section

Smith, A. (1904), Of the Division of Labour. In E. Cannan (red.), *An Inquiry into the nature and Causes of the Wealth of Nations*, Methuen & Co., London, http://www.econlib.org/library/Smith/smWN1.html

Solow, R. M. (1999), Catch the wave: the long cycles of industrial innovation are becoming shorter, *The Economist*, 8107, 7–8.

Sparato, J., (2020), 2 Years of Digital Transformation in 2 Months. Microsoft 365. https://www.microsoft.com/en-us/microsoft-365/blog/2020/04/30/2-years-digital-transformation-2-months

Swan T. W. (1956), Economic Growth and Capital Accumulation, *Economic Record*, 32, 334–361.

Sutter J.D (2009, 23 December), The Top 10 tech trends of 2009, CNN, https:/edition.cnn.com/2009/TECH/12/22/top.tech.trends.2009/index.html,

Swan, J., Scarbrough, H., & Ziebro, M. (2016), Liminal roles as a source of creative agency in management: The case of knowledge-sharing communities, *Human Relations*, 69(3), 781–811.

Šmihula, Daniel (2009). The waves of the technological innovations of the modern age and the present crisis as the end of the wave of the informational technological revolution. *Studia Politica Slovaca*. 1/2009, 32–47.

Taalbi J. (2017), Development blocks in innovation networks, *Journal of Evolutionary Economics*, 27, 461–501.

TAFTIE (2020), ANI led the establishment of the new TAFTIE strategy, The European Network of Innovation Agencis, https://www.ani.pt/en/news/ani-news/ani-led-establishment-new-taftie-strategy/

Technology Pioneers (2020), World Economic Forum, https://widgets.weforum.org/techpioneers-2020

Teulings, C. N., & Zubanov, N. (2014), Is economic recovery a myth? robust estimation of impulse responses. *Journal of Applied Econometrics*, 29(3), 497–514.

Thornhil, J., (2020, 23 March), Coronavirus Monitoring Poses Dangers For Civil Liberties. *Financial Times*, https://www.ft.com/content/d6c877cc-6cfa-11ea-9bca-bf503995cd6f.

Tylecote, A. (1994). Long waves, long cycles, and long swings. in the World Economy. *Journal of Economic Issues*, 28 (2), 477–488.

Turner V. (1967), Betwixt and between: The liminal period in Rites de Passage. In V. Turner (Ed.), *The Forest of Symbols: Aspects of Ndembu Ritual*. Ithaca: Cornell University Press.

Veblen T. (1994), *The Engineers and the Price Systems*, Routledge/Thoemmes, London.

Weick K. (1988), Enacted Sensmaking in Crisis, *Journal of Management Studies*, 25(4), 305–317.

WHO (2020, June), Coronavirus disease, *Situation Report-136*, 152 https://markets.businessinsider.com/news/stocks/coronavirus-pandemic-cost-global-economy-82-trillion-cambridge-study-2020-5-1029218887

White Paper (2020, July), *Critical Frontier: Leveraging Technology to Combat COVID-19*, World Economic Forum, https://www.weforum.org/whitepapers/critical-frontier-leveraging-technology-to-combat-covid-19