IMPACT OF COVID-19 ON KNOWLEDGE PRODUCTION CASE STUDY OF A KNOWLEDGE SOCIETY

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Abstract:

The severe acute respiratory syndrome coronavirus 2 (COVID-19), declared by the World Health Organization on March 11, 2020 as a pandemic, does not represent only a health crisis but a crisis that affects the daily lives of humans around the world, all economic sectors and knowledge production. Our article seeks to demonstrate the impact of the COVID-19 health crisis on the production of knowledge, in the case of a knowledge society. The methodology adopted in our study is form first on the choice of the knowledge society based on the ranking of the Global Knowledge Index (GKI) relating to the year 2019, then the analysis of the variable inputs of the production of the knowledge: the production of knowledge workers, research and development expenditure, and knowledge institutions. Preliminary results show the impact of the COVID-19 health crisis on them. The originality of this article lies in the study of the situation of knowledge production, little covered in recent studies, in this case in the context of the COVID-19 pandemic.

Keywords: *COVID-19, Knowledge production, Knowledge society.*

Introduction

The quantity and quality of knowledge produced by a society demonstrate its capacity to contribute to the global reserve of human knowledge. A radical change in knowledge production has been noticed in the recent decades, and became no longer limited to universities or affiliated to individual disciplinary contexts. In this sense, the knowledge production has undergone a rapid evolution which has

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allowed the establishment of an environment of knowledge co-creation (Burlea-Schiopoiu, 2014, p. 2).

History explains that previous epidemics and pandemics were accompanied by rapid scientific and technological activity and therefore have an increasing impact on knowledge production, measured by the number of scientific publications and patents. The health, socio-economic and human crisis relating to the COVID-19 pandemic is experiencing the same consequences, namely a growing involvement in the tools and quantity of knowledge production on a global level.

The production of knowledge represents an aspect of the knowledge society. This concept refers to a society that creates shares and uses knowledge for the prosperity and well-being of its people. The population of the knowledge society is characterized by a high level of education and an important proportion of its workforce represents the *knowledge workers*. The state and the private sector invest heavily in education, scientific research and development. Private, government and civil society organizations are transforming into intelligent organizations constantly innovating. Hence, the existence of multiple centres of expertise and a polycentric production of knowledge. The knowledge society industry manufactures products with built-in artificial intelligence. There is an emphasis on knowledge organized as digital expertise, stored in databases, expert systems, organizational plans and other media.

Based on the *Global Knowledge Index* for 2019 developed by the UNDP, our study will focus on Switzerland as the first country in the ranking. The COVID-19 pandemic is currently having a significant effect on many aspects of daily life and also on the present behaviours of players in Swiss training, i.e. people, companies, institutions, as well as than on international mobility.

This article aims to demonstrate how the inputs of the knowledge society, Switzerland, have been impacted by the health crisis of COVID-19. In the first section, the article reviews the theory and a presentation of the knowledge society, the knowledge production and knowledge production in times of health crises. The second part explains the choice of country and the methodology adopted. The third

part of the article describes the main results of the research at the input level of knowledge production in Switzerland.

Overview of knowledge production in times of crisis

The knowledge production as a characteristic of the knowledge society: Although its modern aspect, the concept of the knowledge society has known a historical trajectory since the 1940s. The industrial revolutions in the 17th and 18th centuries brought about the emergence of a new socio-economic and technological framework for society, and allowed the opening of a path towards a model of a knowledge society at the beginning of the 20th century (SinghaRoy, 2014, p. 5). In literature, the term *knowledge society* (Hayek, 1945) is sometimes confused with other concepts as the "Society information" (Umesao 1963, Castells 1989), "The service society" (Gershuny and Miles 1983), "the learning society" (Lundvall and Johnsosn 1994), "the scientific society" (Drucker, 1992) or even "the 5.0 society" (Salgues 2018).

Knowledge represents a key driver of productivity and economic growth with significant investments in research and development, education and training in a knowledge society (OECD, 1996). The concept of the knowledge society refers to an economic and social system able to create new ideas, thoughts, processes and products convertible into economic and social wealth (Huggins 2004 Nicolescu and Nicolescu 2005) through the exploitation emerging technologies (Lytras and Sicilia 2005).

The knowledge society presupposes an intensive use of information in all areas of human activity, with significant economic and social impact. New information and communication technologies are used both at the individual level and within organizations with great flexibility, resulting from the independence of human activity linked to space and time. The knowledge society refers to a society that allows all its members to participate in the process of the production and dissemination of knowledge, a society that relies on the knowledge of its citizens to stimulate the dynamism of its economy (Huggins, Johnston, and Steffenson 2008).

The knowledge society is characterized by a high level education of its citizens, an industry with a built-in artificial intelligence, learning organizations and a culture of use and the production of knowledge (UNESCO 2005).

Knowledge production is not limited to the university: The authors of the book *The New Production of Knowledge* (Gibbons et al. 1994) designate it as an essay of reflection around the radical transformation of the knowledge production and the research process (Nowotny, Scott, and Michael 2003). Indeed, the authors describe the development of «mode 1» of knowledge production (Gibbons et al., 1994). Until 1950, this mode was characterized by a certain cleavage between academia and society. The academic world would be based on an autonomous university, independent scientific disciplines and specialties, and the possibility for scientists to decide what is science and truth. There seems to be no interaction between academia and industry. On the other hand, «mode 2» of knowledge production (which would describes science today) characterizes and announces the weakening or even the collapse of the modern university, the disappearance of scientific disciplines and the atrophy of control. Scientists on the direction and content of research programs (Nowotny et al., 2003, p. 2). This mode 2 would be characterized by a new interdisciplinarity, by a great mobility of temporary groups of experts organized provisionally around urgent problems and by the primacy of economic and social problems in the decision to develop a particular sphere of knowledge. Society would thus reject the legitimacy of the prerogatives of science, its institutional autonomy and its epistemological and cultural identity (Shinn 2002).

Knowledge production is no longer affiliated only with individual disciplinary contexts, nor limited to academic institutions (Burlea-Schiopoiu and Burdescu, 2017). Indeed, new non-university players such as public laboratories, industrial laboratories, innovation hubs, technological hubs and 'think tanks' are asserting their influence in a diverse and heterogeneous knowledge production space (Hessels et al. van Lente 2008). In addition, the transformations that the world economy has undergone have made human capital an increasingly crucial input in the production process (Orivel 1996), as well as the production of knowledge is now oriented towards broader impacts that

translate research findings into policy and practice to achieve particular, useful, and actionable ends (Parker, Racz & Palmer, 2018).

Today, the innovation system is at the heart of the problem, the production of knowledge must cross-fertilize the academic sector, businesses, government, civil society and the environment and design ecosystems that are benchmarks to an extended complexity of knowledge production and knowledge translation (Carayannis and Campbell, 2017).

The production of knowledge in times of health crises: The World Health Organization (WHO) declared Severe Acute Respiratory Syndrome Coronavirus 2 (COVID-19) on March 11, 2020 as a pandemic. According to the WHO, COVID-19 is not only a global health crisis due to its unpredictable nature and the lack of adequate drugs (Acter et al., 2020), but that it will affect all sectors (World Health Organization 2020). The challenges remain immense in a health crisis relating to a globally distributed pandemic, and its impact has raised alarm in an exceptional way (Mendes and Carvalho, 2020). The current global COVID-19 pandemic highlights issues of risk, uncertainty, knowledge and cultural values in times of crisis (Hulme et al., 2020).

This is not the first pandemic the modern world has faced. Indeed, influenza A (H1N1) was declared a pandemic in 2009 (WHO 2010), nor the only viral disease that many countries are facing, for example Zika virus, Ebola virus or measles virus. The experiences of such viral epidemics and pandemics have shaped the way governments respond to these health crises (Moy et al., 2020).

Epidemics have caused major changes throughout human history (Uri, 2020), large epidemic outbreaks are accompanied by rapid scientific and technological activity since they represent imminent threats to human life (Colf, Brothers, and Murata, 2016). The Ebola epidemic in West Africa in 2014 illustrates this effect. Research shows that the epidemic has amplified the production of knowledge related to Ebola globally (Quarcoo et al., 2015), creating new interdependencies between scientists, doctors and inventors. Scientific papers and related clinical trials exploded, but what was more revealing was the geographic reconfiguration of knowledge creation activity, placing the most affected African countries as relevant hubs in global networks of

co-author and collaboration, despite the lasting centrality of the traditional scientific centres of North America and Europe, before and during the epidemic (Hagel et al., 2017).

However, the governments responses observed to the pandemic Covid-19 were more important than the previous pandemics, due to the breeding and scattered asymptomatic numbers (Liu et al., 2020). The Covid-19 pandemic has created an unprecedented challenge for knowledge-producing institutions. For many researchers, the shutdown induced by the COVID-19 pandemic was an opportunity to reflect on alternatives to capitalist production methods (Alves and Kvangraven, 2020; Mair, 2020; Spash, 2020).

In its report «Building a knowledge society» (UNDP and AFESD 2003), the UNDP defined the outputs of knowledge production through scientific publications and patents. Indeed, several examples of knowledge production to society in times of health crisis emerged, including medical research (Vaccines, testing, creation of new fans) as well as the analytical work of the socio-economic impact of the pandemic (Teresa, 2020). The COVID-19 pandemic has generated a large number of scientific publications up to 21,400 documents published in the Scopus database in the first half of 2020 (Aristovnik, Ravšelj, and Umek, 2020).

Methodology – Case study

The methodology adopted in our study of the impact of the COVID-19 health crisis on the production of knowledge, more specifically in the case of a knowledge society, is firstly based on the choice of the knowledge society grounded in the ranking of the global knowledge index (GKI) relating to 2019 (UNDP, 2019), then the analysis of the knowledge production variable inputs of the knowledge society defined above. According to the UNDP, the three variable inputs of knowledge production are defined as follows: the first variable represents the output of knowledge workers, the second variable represents research and development expenditure and the third variable represents knowledge institutions (UNDP & Arab Fund for Economic and Social Development, 2003).

Case study of a knowledge society: Switzerland Our study represents the choice of a knowledge society based on the Global Knowledge Index (GKI) developed by the United Nations Development Program (UNDP, 2019). This index is considered as a scientific tool to measure the multidimensional aspect of knowledge, referring to the concepts of the knowledge economy and the knowledge society.

The structure of the GKI index is based on six sub-indices and covers the essential dimensions of development, namely:

- Pre-university education;
- Technical and vocational education and training (TVET);
- Higher education;
- Research, development and innovation (RDI);
- Information and communication technologies (ICT);
- Economy.

A seventh pillar has been added to support sectorial indices, General enabling environment, as these sectors do not operate independently of their environment, but rather in a space governed by a range of contextual factors – political, socio-economic, health and environmental.

According to the 2019 edition of the Global Knowledge Index report by UNDP and the MBRF, Switzerland is at the top of the world ranking. It represents a suitable example for a knowledge society model for this study (UNDP, 2019).

Measuring knowledge production: The UNDP identifies 3 variable inputs of knowledge production (UNDP and AFESD, 2003):

a- Producing knowledge workers: According to F. Drucker, the most important asset of a 21st century institution would be its knowledge workers and their productivity (Drucker, 1999, p. 92). The concept of *knowledge workers* refers to workers, whose activities are mainly centred, to varying degrees, on the creation, production, capitalization, preservation, dissemination and transmission of knowledge (Bouchez, 2006). They are self-managed and involved in defining their scope of work, and insist on the quality and quantity of results (Jacobs, 2017).

b - Expenditures for research and development (R&D): Related to research and development of goods or services of a company, the R&D expenditures are an important element for a continued growth of the company. Indeed, innovative projects are characterized by high risk and by very specific and often intangible assets (Belin, Cavaco, and Guille, 2011). Companies in the industrial, technological, healthcare and pharmaceutical sectors generally have the highest levels of R&D spending.

c- Institutions for research and knowledge development: represented by the higher education institutes, R&D business, research centres and public and government agencies. These institutions seek to generate knowledge about important global issues, resolve transnational disputes over knowledge claims, and provide rationale and evidence to influence global policy-making (A. Miller, 2007).

Impact of the COVID-19 crisis on knowledge production: In terms of knowledge production outputs (scientific publications and patents), the number of international patent applications filed under the PCT was even 6.7% higher in the first half of 2020 than during the same period of the previous year (WIPO, 2019). Thus, the potential remains great for technological breakthroughs and innovations.

Variable 1: Knowledge workers production

Promoting education related to Science, Technology, Engineering and Mathematics (STEM) is a priority in many countries, as scientific skills and those related to problem solving and quantitative analysis are essential in today's unpredictable economy which is increasingly driven by big data and in high demand in the labour market (OECD, 2020).

Switzerland is an interesting example of analysis given its results in mathematics and the unique organization of its education system (Kaufmann and Wittmann, 2018). Over 40% of the Swiss workforce is involved in the creation, dissemination and application of scientific and technological knowledge (SERI, 2020, p. 19). The World Bank Statistics presents a global ranking concerning the knowledge workers in 2020, where Switzerland is in the fourth position while other countries as Germany and France occupy the 11th and the 14th positions respectively (World Bank, 2020).

According to the scenario of the Federal Statistical Office (FSO, 2020), there would be sustained annual increases in the number of university students in 2020 (+ 2%) and 2021 (+ 1.7%) followed a very moderate increase in 2022 (+ 0.3%).

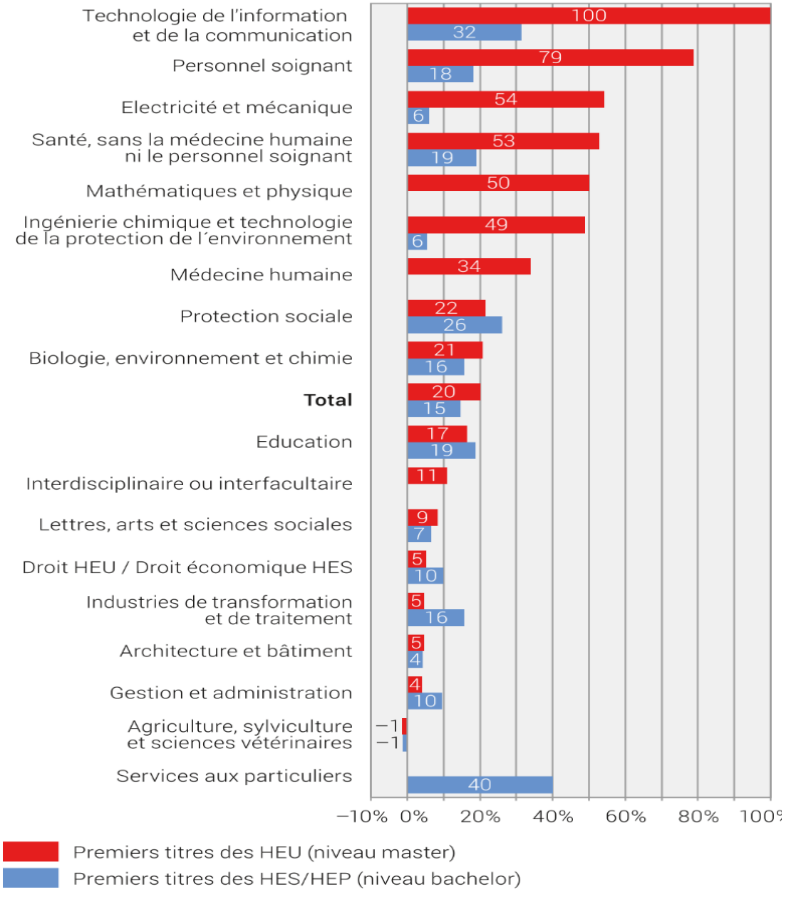

Figure 1: Training outlook – Evolution by field of training in %. Status October 2020 (Source: OFS 2020)

In 15 years, the fields of "Electricity and mechanics" and "Information and communication technology" had increased and represented respectively 73% and 57% of all students at diploma, bachelor or master level (OFS 2020).

These trends are expected to continue over the next ten years and students in the "Information and Communication Technology" field of training at universities (+ 100% of masters awarded between 2019 and 2029).

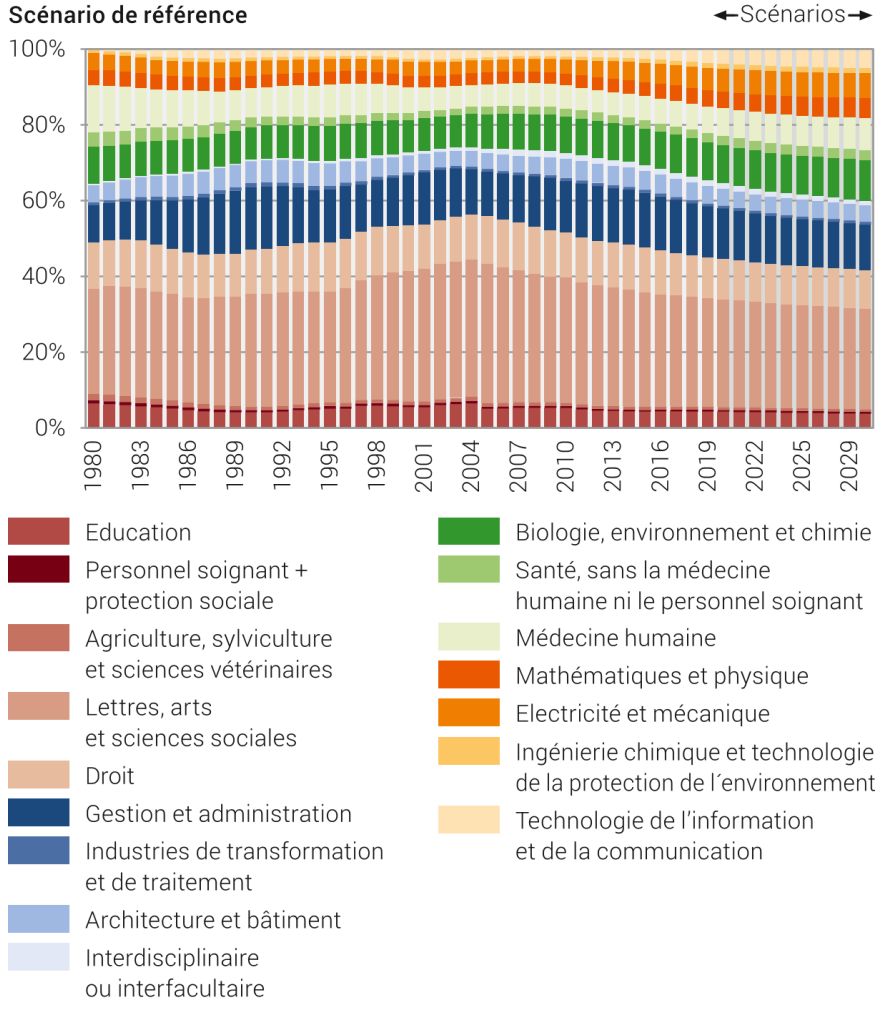

Figure 2: Scenarios 2020-2029 – UTE students at bachelor or master level (Source: OFS 2020)

Due to the COVID-19 pandemic and the economic situation, the holders of a vocational diploma should be more likely to enter specialized universities in 2020 and 2021. The total number of UAS students should then, according to the scenario, grows by 1.7% on an annual average in 2020 and by 2% in 2021 (OFS 2020).

Variable 2: Research and Development (R&D) expenditure

The global GDP will decline by 4.9% in 2020 according to forecasts by the International Monetary Fund (IMF), what about Research and Development (R&D) expenditure?

Research and development represents a source of innovation and knowledge creator whose activities include applied research to develop new products and processes, such as the manufacture of drugs, machines or innovative electronic instruments (OFS, 2020). The Gross domestic expenditure on R&D refers to the total expenditure on R&D work performed by all enterprises, research institutes, and university and government laboratories (OECD, 2017). Indeed, R&D expenditure is highly concentrated in a few thousand companies around the world, with the 2,500 main companies spending on R&D being responsible for 90% of the R&D funded by companies worldwide.

During the previous economic crises (economic slowdown in the early 1990s, early 2000s and the economic crisis of 2009), R&D expenditure has always grown in parallel with GDP (Dutta et al., 2020). Reflecting the economic slowdown, spending on R&D and other innovation spending is expected to decline in 2020 (Cornell University, INSEAD, and WIPO 2020). The main reasons for reducing business innovation spending are reduced revenue and cash flow, overall lower costs, and more risk-averse investors and banks. Companies therefore encounter difficulties in tapping into external sources of funding to support their investments in R&D.

In Switzerland, two thirds of R&D activities are funded and conducted by the private sector (around 2.3% of GDP) (FSO, 2019), while the higher education institutions represents nearly a third of total R&D expenditure (CHF 6.2 billion) (SERI, 2020).

Despite the World Intellectual Property Organization (WIPO) statements which assert that Switzerland has not experienced a drop in R&D spending over the past two decades, and that innovation activity has continued at a high level (WIPO 2019), other reports explain that following the international monetary and geopolitical events of recent years, he art R&D spending declined between 2015 and 2017 (FSO, 2019d). This decrease is explained by the prudence of companies in launching new large-scale R&D projects during the current crises.

The economic sectors where Swiss R&D investments are concentrated in Switzerland, in particular pharma, biotechnologies, industrial techniques and chemicals, are less affected by the pandemic than others (Behrens et al. 2020). The category of R&D investment in Switzerland experienced a negative development. Indeed, various R&D projects have been delayed due to the difficult economic situation (SECO 2020). Investment projects planned for the year 2020 fell sharply in R&D (-14.9%) (Koller, 2020).

Variable 3: Knowledge institutions

Knowledge institution refers to the institute that makes a significant contribution to research and innovation. Knowledge production institutions in Switzerland include:

- *The institutions of higher education* (the Federal Institutes of Technology, cantonal universities, universities of applied sciences (UAS) and universities of teacher education (UTE).
- *Research institutions* (the research centres are like the Swiss Centre of Expertise in the Social Sciences (FORS) that collect, process, analyse and make available information and scientific documentation as a basis for further research. The art institute's research such as the Swiss Institute of Allergies and Asthma Research (SIAF), centres of technological excellence such as the Swiss Centre for Electronics and Micro Technology (CSEM) which focuses in particular on knowledge transfer and technologies.
- *The companies engaged in R & D*: The Swiss companies increased their R&D spending since 2009 and are now well above the average for the overall economy. According to the Swiss Start-up Radar,

around 300 start-ups are created in Switzerland each year, four times more than 15 years ago. In an international comparison, Switzerland has a high proportion of start-ups in the fields of medtech; mechanical and electrical engineering; clean energy and technologies, biotechnology; and financial services (startupticker.ch, 2018).

The impacts of the COVID-19 pandemic on the productivity of knowledge institutions in Switzerland could be defined in the change in the remote working mode, applied since the closure of schools and universities on March 17, 2020 (Bott 2020), reduction of international education and cancellation of a number of national and international conferences (OECD 2020). Knowledge institutions play a central role in the development of knowledge and are closely linked to the teaching process (Burlea-Schiopoiu and Rainey, 2013).

Conclusion

Historically, the production of knowledge in times of previous health crises has always experienced development. Previous pandemics and epidemics such as influenza A (H1N1), Zika virus, Ebola virus or measles virus have created new interdependencies between scientists, doctors and inventors which allowed an amplification patents, clinical trials and the scientific articles. The analysis of the impact of the COVID-19 health crisis on the production of knowledge is now still unclear due to the unavailability of statistics relating to the variable inputs of the production of knowledge. A future quantitative study will best present the impact of the current health crisis on the production of knowledge workers, R&D spending and the production of knowledge institutions.

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