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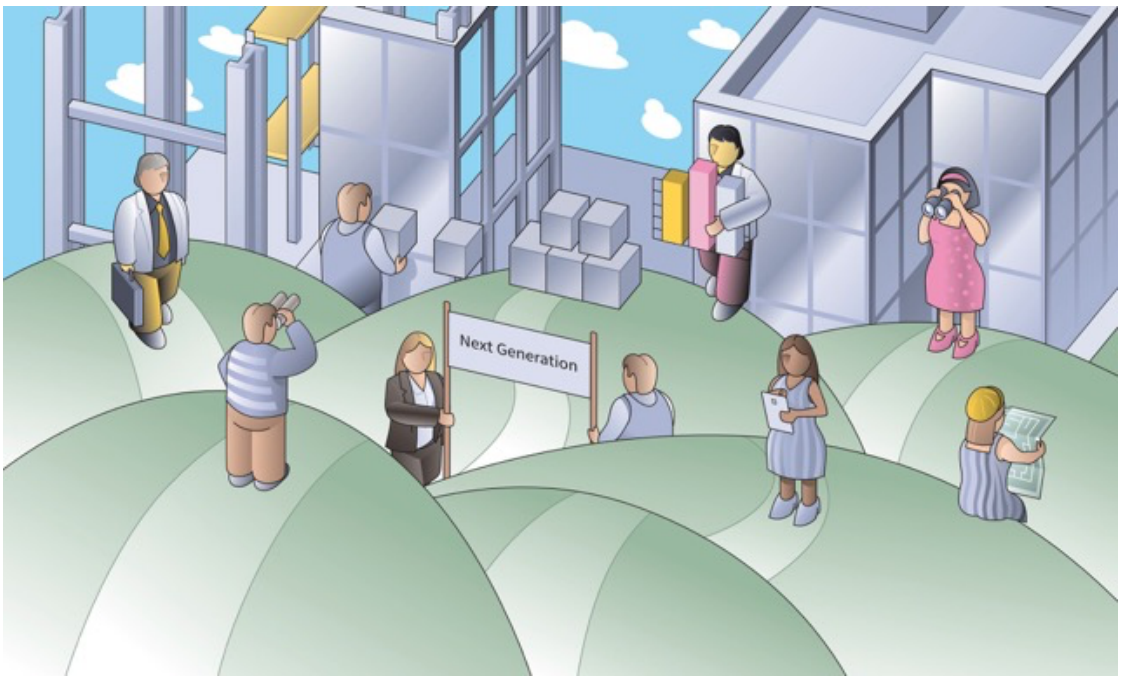
Views from Generation Y



Does Technology Contribute Towards Making Longevity a Sustainable Achievement? The Cases of Productivity and Healthcare

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1. Introduction

In the pre-modern world, life expectancy around the globe is estimated to have been 30 years (Roser, 2019). In the 1800s, a series of technological developments emerged that forever changed the prospects of the human species. Toilets and other advancements in sanitation saved millions of lives, synthetic fertilizers drastically reduced the dangers of malnutrition, and vaccines saved humanity from horrible plagues. In less than 200 years – a negligible amount of time in evolutionary terms – humanity managed to overcome most serious threats from the pre-modern world and today benefits from a life expectancy greater than 70 years (United Nations, 2015). Ironically, despite the tremendous benefits brought by innovation, one of the most pressing concerns now faced by humanity arises precisely from the advancements of longevity.

Longevity, paired with a decline in birth rates, is causing the composition of the world population to rapidly change. In fact, the portion of the population aged 65 and over is increasing more rapidly than any other age group (United Nations, 2019). In this paper, I define two problems that arise from this demographic trend: *insufficient productivity* and *unsustainable healthcare*. My goal is to define the most important ways in which technology can help humanity overcome these two problems and make longevity more sustainable. Following this introduction, section 2 briefly covers the topic of productivity, section 3 extensively covers the topic of healthcare, and section 4 concludes the paper.

2. Productivity

In order to understand the economic problem that arises with strides in longevity, it is important to analyze the data in per capita terms. Considering the observed trends in the composition of the world population, if all else remains unchanged, theory predicts that the economic output per capita in terms of GDP will decline. This result follows from the fact that the share of the population represented by active workers and infants is declining while the share of the population represented by the elderly is rising. Japan is a country that fits this description particularly well, as displayed in Figure 1.

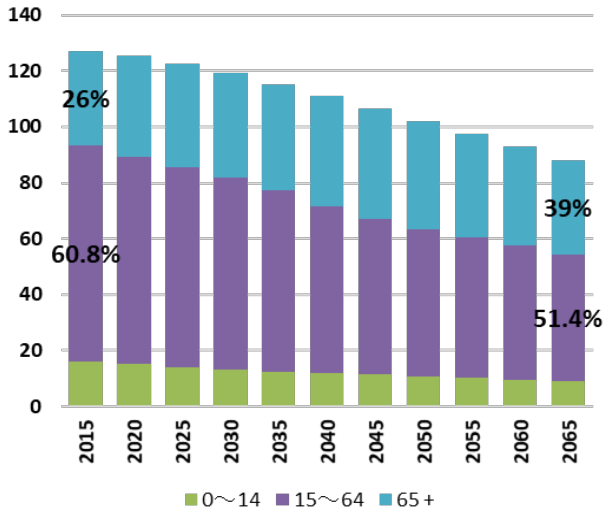

Figure 1: Expected Population Composition and Development in Japan by Age (in millions). From the National Institute of Population and Social Security Research (国立社会保障・人口問題研究所) 2017.

Assuming that the active working population is responsible for generating the most economic output, it follows that output per capita must decline. Fortunately, this model relies on the unlikely assumption of *ceteris paribus*: it assumes that everything else in our society will remain unchanged, including our work culture, how society is organized, and technological developments.

The solution to the productivity problem can take many forms. A good example is the current change in the work culture, as governments across the world are raising the legal retirement age. Among the EU Member States, the retirement age is 65 years on average. Spain, Germany and France are expected to soon raise the retirement age to 67, while in Britain and Ireland the goal is age 68 (Finnish Centre for Pensions, 2019). However, the most promising solution to the productivity problem is technological innovation. Similar to raising the retirement age, technology can enable the ageing workforce to continue to complete high-valued-added tasks later in life. Many technologies support the ageing workforce, including digital collaboration tools that facilitate working from home, advancements in healthcare that promote prolonged uncompromised vision and hearing, medical developments

that improve morale and general healthy living, and self-driving cars that facilitate mobility.

In addition to enabling older adults to work for longer, technology primarily increases productivity by introducing new production methods and management techniques that increase the efficiency of the workforce. Innovations in artificial intelligence (AI), 3D printing, Internet of Things (IoTs), blockchain, biotechnology, and industrial robots have drastically increased the output of the private sector and will continue to revolutionize how businesses operate. In fact, in their recent paper "Secular Stagnation? The Effect of Aging on Economic Growth in the Age of Automation," Dr. Acemoglu and Dr. Restrepo (2017) showed that not only is there no evidence that an ageing population leads to lower productivity per capita, but that the opposite relationship may be true. They suggest that an ageing workforce may lead to more rapid adoption of automation technologies, which ultimately explains the higher levels of productivity observed in countries where this demographic trend is more pronounced.

3. Healthcare

In an influential paper published in the journal of *Health Services Research*, Dr. Alemayehu and Dr. Warner (2004) analyzed healthcare costs in the United States and found that nearly half of an individual's healthcare costs are incurred during his or her senior years. They found that for people who live past the age of 85, more than one-third of their lifetime healthcare expenditures accrue in those remaining years of life. The distribution of lifetime healthcare costs, paired with the evident population ageing trend, creates serious sustainability problems. How can governments make sure that the elderly population has access to the resources that it needs, without compromising public spending in other domains? How can societies make sure that the supply of healthcare can keep up with the rising demand, so that all those in need can have access to proper care?

As is the case with productivity, there are many potential solutions to the healthcare problem. In part, governments must foster a fair and competitive healthcare industry, incentivize the adoption of healthy habits by the population, and perfect the financing dynamic of healthcare systems. However, the most promising solution to the healthcare problem is once again technological development. Specifically, technology will help cut healthcare costs and improve the quality of care in three ways:

1. ***Prevention:*** *Reducing the demand for care.*
2. ***Cure:*** *Eradicating diseases.*
3. ***Care:*** *Facilitating in-home care.*

In the following sub-sections, I describe the reasoning behind each of the proposed methods and provide concrete examples of technologies that are contributing – or will contribute – to making healthcare a sustainable achievement in the face of longevity.

3.1 Prevention

The most straightforward method for reducing healthcare costs is to reduce the need for medical procedures. A technology taking one step towards this goal is *preventive disease wearables*. Wearable devices are already widely popular in the realm of physical activity, but they have also recently started to contribute to the field of medicine. These devices, which range from wrist bands to headsets, are used to monitor the user's health vitals, detect illnesses, collect biometric data, and even help with the patient's diagnosis. According to the Centers for Disease Control and Prevention (CDC), chronic diseases account for approximately 90% of the $3.5 trillion USD annual healthcare costs in the United States (Buttorff et al., 2019). The use of preventive disease wearables makes it easier for doctors to determine the patient's symptoms, reach a diagnosis, and steer at-risk patients towards lifestyle habits that could prevent the emergence of chronic diseases.

Another technology that has the potential to revolutionize preventive care is *genomics.* Genomics is the field concerned with the structure, function, and mapping of genomes. Historically, DNA testing has been a technology unfamiliar to the general population, exclusive to laboratories and scientific research. However, it has recently become a widely commercialized procedure. The company Ancestry.com, a pioneer in the industry of ancestry and relationship DNA testing, had an estimated market value of $3 billion USD in 2017 and is reported to have sold over 15 million DNA kits to customers (Porter and Sherman, 2017).

Most importantly, the application of genomics targeted at preventive care is gaining popularity and becoming accessible to the wider public.

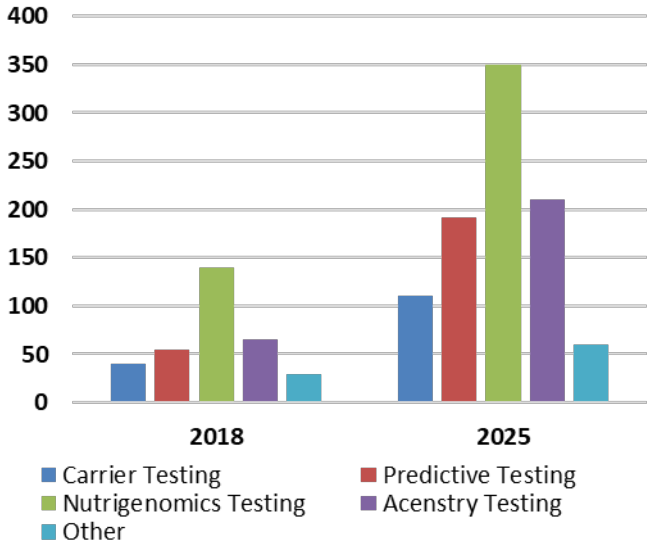

Figure 2: Genomics Market Size in the U.S. by Usage Category (in million USD). From Global Markets Insights. "U.S. DTC Genetic Testing Market Size." Published September 2019.

Figure 2 shows the current and expected market size for different DNA testing categories. Predictive testing is expected to have the highest compound annual growth rate among the groups, approximately 20% in the period 2018 to 2025 (Global Markets Insight Research, 2019). Genomics allow patients to acquire a complete understanding of their genetic composition, including genetic risk factors (e.g. genetic predispositions), and allow caretakers to respond with preventive measures years before any related illness emerges.

3.2 Cure

In addition to prevention, technology can help make healthcare more sustainable by eradicating costly diseases. The *variola* virus, the cause of *smallpox* disease, plagued humanity for nearly 12,000 years and is believed to have been responsible for approximately 300,000,000 deaths (Flight, 2011). In May of 1980, the World Health Organization (WHO) certified the eradication of smallpox – the first disease to have been deliberately eradicated by humans. Although vaccines are one of the most important discoveries in medicine, humanity is on the brink of a medical innovation that may be the most impactful to date. I am referring to *gene editing*, the practice of inserting, deleting, and replacing DNA, ultimately modifying the genome of a living organism.

Gene editing has a wide range of possible applications, from the most realistic and near-term (e.g. pest control) to the most far-fetched and futuristic (e.g. reviving extinct animals and designing babies). Most gene editing is currently done through a technology called Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR). A simple and yet useful analogy to how the technology works is a *molecular scissor*: doctors cut out two strands of DNA at a particular location of the genome so that bits of DNA can be added or removed.

To illustrate the power of CRISPR, one can consider the case of malaria, a disease that kills half a million people every year throughout sub-Saharan Africa. Scientists from Imperial College London successfully completed an experiment in which they implanted a deadly gene in Anopheles mosquitos – the transmitters of malaria – that kills only female mosquitoes but that is passed on by both males and females from generation to generation. The experiment resulted in the complete extermination of the Anopheles mosquitos from the sample in as few as 7 generations (Kyrou et al., 2018). One can reasonably expect that the experiment will soon be applied to exterminate malaria as well as many other zoonotic diseases.

Although the application of gene editing in malaria control is promising, it is only the starting point when it comes to where gene editing could be taking humanity. The technology is still in its infancy and extensive research must be completed before scientists can unlock the full potential of CRISPR. Nonetheless, as a concept, gene editing has the potential to eradicate every genetic disease from existence, ultimately increasing the well-being of humans and alleviating healthcare expenditures.

3.3 Care

In sections 3.1 and 3.2 I described how technology will have an impact on healthcare as a whole, via the prevention and cure of diseases. In this section I describe how technology can aid in caring for the elderly.

Technology primarily plays a role in elderly care by enabling in-home care, as opposed to in-hospital care. A recent study published in the *Journal of General Internal Medicine* showed that in-

home healthcare leads to a more than 50% reduction in costs relative to in-hospital care (Levine et al., 2018). Unlike hospitals patients, at-home patients do not need 24/7 labor available and do not induce expenses for occupying the hospital room, both of which are primary in-hospital costs. In addition, because of its convenience, in-home care is also preferred by most patients. It is evident that the adoption of in-home care would be advantageous to both the financing of the healthcare system and to the well-being of patients. Therefore, the question that follows is: how is technology enabling in-home care?

While in the past in-home care was rarely an option, today portable health monitoring devices and improved communication systems (e.g. tele-health) have made in-home care a reality. Remote monitoring sensors feed real-time patient data to doctors and nurses, warning caretakers when any risk indication emerges. Tele-health apps allow patients to video conference with doctors on demand, obtain prescriptions via the application, and schedule appointments. AI robots, as the ElliQ system displayed in Figure 3, paired with the Internet of Things (e.g. home appliances integrated to the virtual system), can assist the elderly in executing routine tasks and promote a more engaged and happier life.

Figure 1: ElliQ. AI-Driven Robot Developed by Intuition Robotics. Targeted at Elderly Care.

Finally, with the ageing world population, the market for age-tech – technology targeted at the population aged over 65 years – will continue to grow. As the market grows and becomes more lucrative, it attracts the private sector and triggers more innovation. In the future, we can expect age-tech to play a central role in elderly care and to continue facilitating in-home treatments, both improving the quality of life for the elderly and reducing the costs of care.

4. Conclusion

In this brief paper, I identified two problems that arise from the advancements in human longevity: *insufficient productivity* and *unsustainable healthcare*. In respect to productivity, I proposed that technological advancements enabling work to continue in later life and increasing industrial output will more than offset the decline in GDP per capita predicted by longevity and low birth-rates. With respect to healthcare, I proposed that wearable devices, AI, tele-health, genomics, and gene editing, among other technologies, will revolutionize healthcare in respect to prevention, cure, and care, ultimately making healthcare more sustainable. Finally, it is important to note that both the problem of *insufficient productivity* and *unsustainable healthcare* will not be resolved by any individual solution proposed in this paper, but instead by the joint influence of technological developments and structural change in our society, among other factors.

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