THE IMPACT OF ICT INVESMENT, EXCHANGE RATE AND INFLATION ON HEALTHCARE EXPENDITURE IN G20 COUNTRIES

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PLAGIARISM

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

Health and investments in health are crucial components of human capital and have a positive relationship with economic growth according to endogenous growth theories. This study investigates the relationship between exchange rate, inflation rate, ICT (Information and Communication Technology) investments in the health sector, and health expenditures in G20 countries over the period of 2000-2019 using panel data analysis. Health expenditures are decomposed into different categories such total health expenditure, government health spending, private sector health spending and household health spending for more specific policy analysis. The empirical findings reveal that exchange rate, GDP, and general government final consumption expenditure are significant determinants of health spending. Our results show that the health sector ICT investment is a significant determinant of domestic private health expenditure per capita and out-of-pocket household expenditures per capita, indicating the importance of investments in health technologies for private sector health expenditures. However, it has no effect on current health expenditure per capita and domestic general government health expenditure per capita, suggesting that government health expenditures are not related to ICT investments. This study contributes to the understanding of the financial variables affecting health expenditures and provides insights for policymakers to take appropriate actions to ensure uninterrupted access to health services in the face of fluctuations and changes in health expenditures.

Keywords: ICT investment, Exchange rate, Inflation, Healthcare expenditure, G20 countries

ÖZET

Sağlık ve sağlığa yapılan yatırımlar beşerî sermayenin önemli bileşenleridir ve içsel büyüme teorilerine göre ekonomik büyüme ile pozitif bir ilişkiye sahiptir. Bu çalışma, 2000-2019 döneminde G20 ülkelerinde döviz kuru, enflasyon oranı, sağlık sektöründeki Bilişim ve İletişim Teknolojileri (BİT) yatırımları ve sağlık harcamaları arasındaki ilişkiyi panel veri analizi kullanarak araştırmaktadır. Sağlık harcamaları, daha spesifik politika analizi için toplam harcamalar, devlet harcamaları, özel sektör harcamaları ve hanehalkı harcamaları gibi farklı kategorilere ayrıştırılmıştır. Ampirik bulgular, döviz kuru, GSYH ve genel hükümet nihai tüketim harcamalarının sağlık hizmetlerinin önemli belirleyicileri olduğunu ortaya koymaktadır. Sağlık sektörü BİT yatırımları, kişi başına düşen yurtiçi özel sektör sağlık harcamalarının ve kişi başına düşen hanehalkı sağlık harcamalarının önemli bir belirleyicisidir ve bu da sağlık teknolojilerine yapılan yatırımların özel sağlık harcamaları için önemini göstermektedir. Bu çalışma, sağlık harcamalarını etkileyen finansal değişkenlerin anlaşılmasına katkıda bulunmakta ve politika yapıcıların sağlık harcamalarındaki dalgalanmalar ve değişimler karşısında sağlık hizmetlerine kesintisiz erişimi sağlamak için uygun önlemleri almalarına yönelik içgörü sağlamaktadır.

Anahtar kelimeler: BİT yatırımları, Döviz kuru, Enflasyon, Sağlık harcamaları, G20 ülkeleri

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With heartfelt gratitude,

Mert BAYDAR

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CHAPTER 1

INTRODUCTION

Despite being one of the leading development indicators, health expenditures play an essential role in the country's economy. To raise healthy generations, health expenditures are significant (Oztürk & Ucan, 2017). For the continuation of people's existence, the significance of health has steadily increased over time. To better measure the effects of health on human life, it would be necessary first to define health economics. Health economics is an economics subfield. As implied by the definition of economics, satisfying limitless demands and needs with limited resources have become the norm in every aspect of life. A crucial element of a healthy society is its effect on the national economy. An increase in the number of healthy people in a country will substantially impact the economy. A more conscientious, productive, and qualified workforce will be developed, and the quality workforce will be receptive to innovation; the problem that needs to be handled will be resolved swiftly, and all of these factors will positively affect the economy.

Human capital is one of the most important economic growth factors. Being in excellent mental or physical health is vital for employment. In developing nations, the relegation of health services to the background spread of infectious diseases to more individuals and the incapacity to provide preventative health care is detrimental to public health. In contrast, the economy of the nation is negatively impacted. In developed countries, healthy societies produce rapid economic expansion. The insufficient number of healthy individuals hurts the economy of developing nations.

Health and investments in health are the most crucial component of human capital. In the economics literature, endogenous growth theories explain the relationship between health and economic growth. The association between health expenditures and economic growth has been generally positive. Enhanced human welfare has resulted from the combination of more significant investments in the health sector and technological advancements.

G20 countries are the most appropriate group for evaluating health expenditures since they include Turkey. G20 countries account for 70% of the world's population, 85% of global trade and 90% of the world's real added value (Aslan & Aslan, 2014, p.94). Seven of the G20 countries (Germany, Australia, France, South Korea, the United Kingdom, Japan, and Canada) are among the 20 countries with the most developed health systems, according to a 2016 study conducted by the Legatum Institute Foundation, which ranked the development of health systems in terms of fundamental physical and mental health, health infrastructure, and preventive services. In the same survey, twelve G20 nations are among the top 50. Based on these facts, it may be concluded that G20 nations do better than others in economic and health system development (Legatum Institute Foundation, 2016, p.4-5).

1.1 Background

Healthcare spending is a significant aspect of global economies, involving private organizations, governments, and households. According to World Health Organization (WHO) data, global healthcare spending has been on the rise, reaching 10% of global gross domestic product (GDP) in 2019 (WHO, 2020). This indicates the importance of healthcare expenditure in the global economy.

ICT (Information and Communication Technology) investment has emerged as a crucial factor in all sectors, including healthcare. ICT encompasses technologies such as electronic health records, telemedicine, and health information systems, which have the potential to improve healthcare delivery and outcomes (World Bank, 2019). Global ICT investment has been increasing steadily, with estimates showing that it reached USD 4 trillion in 2019 (World Bank, 2019).

In the healthcare sector, ICT investment has also been on the rise, with the adoption of electronic health records, telehealth services, and other digital health technologies (OECD, 2020). For instance, the use of electronic health records has increased in many countries, leading to improved healthcare coordination and efficiency (OECD, 2020). Furthermore, telehealth services have gained prominence, especially during the COVID-19 pandemic, as they enable remote delivery of healthcare services (OECD, 2020).

ICT (Information and Communication Technology) investment refers to the allocation of resources, including financial, human, and technological, towards the development, adoption, and utilization of ICT tools, systems, and infrastructure. ICT encompasses a wide range of technologies, such as computers, networks, software, mobile devices, and the internet, which enable the collection, processing, storage, and exchange of data and information.

ICT investment is globally recognized as a crucial driver of economic growth, innovation, and productivity across all sectors, including agriculture, manufacturing, services, healthcare, education, and government. It facilitates communication, collaboration, automation, and digitization of processes, leading to increased efficiency, cost savings, and improved decision-making.

Here are some statistics that highlight the global importance of ICT investment:

I. Global ICT spending: According to Statista, worldwide spending on ICT is projected to reach $4.3 trillion in 2021, reflecting the increasing reliance on technology across industries. (Statista, 2021)

II. ICT adoption in businesses: The World Bank's Enterprise Surveys indicate that ICT adoption by businesses is widespread, with over 90% of firms in high-income countries using computers and internet services for their operations (World Bank. n.d.).

III. ICT and economic growth: The International Telecommunication Union (ITU) estimates that a 10% increase in ICT investment can lead to a 0.9-1.5% increase in a country's GDP, demonstrating the positive impact of ICT on economic growth (International Telecommunication Union. n.d.).

IV. Digital divide: Despite the global importance of ICT investment, there is a digital divide that exists between developed and developing countries, as well as within countries. The ITU reports that over half of the global population still lacks internet access, highlighting the need for increased ICT investment to bridge this gap and ensure inclusive digital development (International Telecommunication Union, 2020)

V. Sector-specific ICT investment: Various sectors benefit from ICT investment. For example, in healthcare, ICT investment enables telemedicine, electronic health records, and remote patient monitoring, improving access to healthcare services. In agriculture, ICT investment facilitates precision farming, supply chain management, and market access, enhancing productivity and sustainability (European Commission. n.d.).

Overall, ICT investment is critical in driving economic growth, fostering innovation, and improving productivity across all sectors globally.

Inflation and exchange rate are other important factors that can influence healthcare expenditure. Inflation refers to the increase in the general level of prices of goods and services over time, while exchange rate refers to the value of one country's currency in relation to another country's currency. Both inflation and exchange rate can affect healthcare spending in various ways.

For instance, inflation can impact healthcare spending by affecting the cost of medical goods and services, as well as labor costs in the healthcare sector (Dumrauf et al., 2018). Exchange rate fluctuations can also influence healthcare spending, as it can affect the cost of imported medical goods and services, as well as impact the revenue generated from medical tourism (Hartwig et al., 2017).

In addition, exchange rate and inflation can also impact ICT investment in healthcare. Exchange rate fluctuations can affect the cost of importing ICT technologies, while inflation can impact the cost of ICT investment, as well as the availability of funds for investment (Dumrauf et al., 2018). Understanding the relationship between ICT investment, exchange rate, inflation, and healthcare expenditure is crucial for policymakers and healthcare stakeholders to make informed decisions.

The G20 countries, consisting of 19 countries and the European Union, are recognized as the world's major economies, accounting for approximately 80% of global GDP (G20, 2020). The G20 countries play a significant role in shaping global economic policies, including healthcare expenditure and ICT investment. Therefore,

studying the impact of ICT investment, exchange rate, and inflation on healthcare expenditure in G20 countries is of great importance.

In this study, we aim to examine how ICT investment, exchange rate, and inflation affect healthcare expenditures in G20 countries using panel data analyses. Results obtained from this study may benefit policy makers, managers, corporations, investors and researchers as our findings contribute to understanding of the factors influencing healthcare expenditure and thus policy decisions and healthcare strategies in G20 countries.

1.2 Research Questions

1. Is there a relationship between health expenditures and health sector ICT investments?
2. Is there a relationship between health expenditures, inflation, and exchange rate?

These research questions aim to investigate the impact of exchange rate and inflation rate on health expenditures in G20 countries, as well as the relationship between health expenditures and ICT investments in the health sector in a subset of G20 countries based on data availability during the period of 2000-2019.

1.3 Significance of the Work

This study holds significant importance for several reasons. Firstly, it contributes to the literature on health economics by examining the relationship between health expenditures, exchange rate, inflation rate, and ICT investments in the health sector, using a comprehensive dataset from G20 countries for the period of 2000-2019. This study fills the gap in the existing literature by providing empirical evidence on how

financial indicators and ICT investments may impact health expenditures, which are crucial for human capital development.

Secondly, the findings of this study can provide valuable insights for policymakers and stakeholders in the health sector. Understanding the relationship between health expenditures and financial indicators can help policymakers make informed decisions about resource allocation, budgeting, and policy planning in the health sector. Moreover, insights into the association between health expenditures and ICT investments can inform strategies for harnessing technology in the health sector to improve health outcomes and delivery of healthcare services.

Thirdly, this study has implications for international health policy and cooperation among G20 countries. As the G20 countries represent a significant share of the global economy and population, the findings of this study can contribute to the understanding of the dynamics between health expenditures, financial indicators, and ICT investments in these countries. The findings can inform discussions and policy debates related to international health policy coordination, cooperation, and collaboration among G20 countries to address global health challenges and achieve health-related sustainable development goals.

1.4 Definition of Terms

In this study, several key terms are used, which are defined as follows:

- Health Expenditures: Refers to the total amount of money spent on healthcare goods and services within a specific time period, including both public and private expenditures. This may include spending on hospitals, clinics, medical personnel, pharmaceuticals, medical equipment, and other healthcare-related expenses.

- Human Capital: Refers to the knowledge, skills, abilities, and health of individuals that contribute to their productivity and economic potential. In the context of this study, health expenditures are considered as an essential component of human capital, as investments in health can improve the overall well-being and productivity of a population.
- Exchange Rate: Refers to the value of one currency expressed in terms of another currency. In this study, exchange rates will be considered as a financial indicator that reflects the relative strength or weakness of a country's currency compared to other currencies, and can impact international trade, investment, and economic stability.
- Inflation Rate: Refers to the rate at which the general level of prices for goods and services in an economy increases over time. In this study, inflation rate will be considered as a financial indicator that reflects the changes in the purchasing power of a currency, and can impact consumer behavior, investment decisions, and overall economic performance.
- ICT Investments: Refers to investments made in Information and Communication Technology (ICT), which includes technologies used for communication, data processing, and information management. In the context of this study, ICT investments in the health sector will refer to investments made in technology-related solutions, such as electronic health records, telemedicine, health information systems, and other ICT applications in the healthcare industry.
- G20 Countries: Refers to the group of 20 major economies that come together to discuss and coordinate on international economic and financial issues. The G20 countries include Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South

Korea, Turkey, the United Kingdom, the United States, and the European Union. In this study, the focus will be on the health expenditures and their relationship with other financial indicators in the G20 countries (except the European Union) during the research period from 2000 to 2019.

It's important to note that these definitions are used in the context of this study and may be subject to interpretation or different meanings in other contexts or disciplines.

1.5 Organization of the Work

This study's organization is structured coherently and logically to ensure a clear presentation of the research findings. The sections of the study are outlined as follows:

- Literature Review: The second part of the study focuses on health economics, health expenditures, and factors affecting health expenditures. It includes a comprehensive review of the relevant literature on the relationship between health expenditures and technological innovation, as well as the relationship between health expenditures and exchange rate and inflation rate. Proper citations and references will be used to support the literature review, ensuring academic integrity.
- Sample and Methodology: The third section of the study presents the sample, methodology and data used to analyze the relationship between the variables of interest. It describes the research design, data sources, data collection methods, and data analysis techniques that will be employed in the study.
- Empirical Results: The study concludes with the presentation of the research findings in this section. The results of the data analysis conducted in the methodology section will be presented clearly and organized, using appropriate

tables, figures, or charts to facilitate understanding. The findings will be discussed in relation to the research questions and the literature review, and relevant references will be provided to support the findings.

- Conclusion and Discussion: Following the empirical results section, this section will interpret the findings of the study in light of the research questions, literature review, and theoretical framework. It will provide an in-depth analysis and interpretation of the results, discussing the implications of the findings and comparing them with previous research or theories. The study will conclude with a summary of the main findings, their implications, and recommendations for future research or policy implications. This section will reinforce the work's significance and highlight the study's contributions to the field of research.

CHAPTER 2

LITERATURE REVIEW

2.1 Determinants of Healthcare Expenditures

In economic theory, various types of factors can have an impact on health expenditures. The main ones are political factors that can create changes in health expenditures; government ideology can be one of these determinants, and general costs are higher in a socialist country compared to a liberalist country. Other determinants include the socio-economic and cultural status of the country (Samadi et al., 2013:63-68). The pressure created by the positive relationship between health and economic growth and the demand of all individuals to be healthy has required states to assume a regulatory role in health services. (Çevik & Taşar, 2013).

Healthcare expenditures generally refer to the payments made to protect and develop health (Akar, 2014). Healthcare expenditures; consist of the sum of out-of-pocket health expenditures made by individuals, state contributions to health services, and health investment expenditures made by the private sector and the public (Yalçın and Çakmak, 2016). In this context, preventive health expenditures, expenditures made for diagnosis and treatment and payments made for rehabilitative health studies, medical supplies used in these procedures, other consumables, machinery and equipment costs, personnel expenses, construction of new health facilities, and maintenance of existing facilities, machinery and equipment and the payments made for its repair constitute the health expenditures (Census, 2017).

After Grossman defined the relationship between health and human capital and evaluated health as investment capital for people, health expenditures became an

essential factor for productivity and the economy (Grossman, 2017). Internal growth models also support Grossman's model, emphasizing the impact of human capital on economic growth and development (Romer, 1990). Bloom et al. (2001) defined the relationship between health and economy with four mechanisms; (i) in the workplace, healthy individuals are more productive and therefore have higher incomes overall, (ii) healthy individuals retire late and take fewer leave due to generally good health so they can work longer, (iii) self-education and they are more likely to invest in their teaching, which increases their productivity; and (iv) with a longer life expectancy, they are more likely to save and invest. The World Health Organization reported that a 10% increase in life expectancy at birth would impact 0.3% to 0.4% economic growth (Sachs, 2002).

Studies by Nixon and Ulmann (2006) and Anyanwu and Erhijakpor (2009) reported that health expenditures positively affect health outcomes. In contrast, Musgrove (1996) and Filmer and Pritchett (1999) concluded that health expenditures are not a significant factor in health outcomes. Fayissa and Gutema (2005) reported that the increase in health expenditures hurts life expectancy at birth.

Rajkumar and Swaroop (2008); emphasizing that the governance mechanism of the public plays a vital role in the effectiveness of public health expenditures; found that a 1 percent increase in the share of public health expenditures in GDP in countries with good governance reduces the under-5 mortality rate by 0.32%, and 0.20% in countries with average power, while it has no effect in countries with a weak government. These findings explain why public spending often fails to deliver the expected improvement in human development outcomes.

In the period we live in, countries evaluate every expenditure implemented to use scarce resources in productive areas within the framework of development plans

economically, and the extent to which the expenditures realized converge to the target is investigated. It is an inevitable fact that health expenditures are increasing rapidly worldwide. In this context, it is of great importance to reveal the underlying causes of health expenditures, which constitute the majority of public spending worldwide (Akın, 2007, p.31). As a result of the research, it has been concluded that the reasons for the increase in health expenditures of developed and developing countries are generally similar. The reasons for the rise in health expenditures can be listed as economic, technological, social, and cultural factors (Hansen, King, 1996, p.127). Among the most fundamental reasons for the increase in health expenditures are rising incomes, rising needs, and rising costs (Whyness, 1993, p.172).

2.1.1 Increase in Per Capita Income as a Factor Affecting Health Expenditures

With the development of production techniques after a certain period, countries increase their production and, indirectly, their incomes, which in turn leads to an increase in the demand for services that will enable people residing in the country to live a more comfortable life. Securing the lowest level needs through the government or other institutions increases the demand of individuals for goods and services other than basic needs (Musgrave & Richard, 1969, p.12).

An increase in a country's national income leads to an increase in the resources allocated to health (Belek, 2001). Along with the positive change in GDP, the increase in the income levels of individuals also leads to a shift in consumption patterns. Individuals with higher income levels tend towards services that will provide better and more comfortable living conditions. Health services are among these services.

Individuals' demand for better living conditions leads to increased health services offered by the public and private sectors and health expenditures (Mutlu and Işık, 2005). In other words, if there is any problem in terms of physical and mental health, the individual can apply to health institutions for treatment. This situation positively affects health, which is the person's primary need.

The higher the level of development in countries, the higher the share of GDP allocated to health expenditures. Based on the last decade, health expenditures in G20 countries have increased by an average of 4.4%. In addition, it has been determined that the share allocated for health expenditures is numerically higher with the increase in the incomes of countries over time (OECD Health Data, 2006).

Çelik, (2013) found that expenditures on food products increase at a lower rate than the increase in the income of the consumer; on the contrary, expenditures on housing increase in direct proportion to the payment of consumers, and finally, expenditures such as culture, entertainment, health, and transportation will increase at a higher rate than the increase in the income of consumers. As a result, the number of health services consumed increases at a similar rate to the rise in revenue. Specificity is significant for health services. For example, when individuals do not have any ailment, they do not want to utilize hospital services and undergo surgical intervention due to the increased income. On the contrary, they may want to benefit from various health services, such as plastic surgeries, to eliminate deferred and personal health needs (Çelik, 2013, p.121).

One of the most important reasons for the increase in health expenditures is the change in GDP. Although the debate on the income elasticity of health expenditures continues in most of the studies in the literature, it is seen that income growth is one of the main

factors in expenditures (OECD, 2022). It is generally accepted that it has an increasing effect, especially concerning public health expenditures.

2.1.2 Population as a Factor Affecting Health Expenditures

Hjalte and Glenngård (2007) analyzed the determinants of health expenditures in Sub-Saharan African countries; They stated that the population, the distribution of the people in the country, and the regional needs should be given a special place when planning the health services of the nations.

Mendelson and Schwartz (1993) have stated that countries' health expenditures should also increase significantly, and they are growing with the increasing population. These researchers, who noted that the changing demographic structure, mainly through international migration, will change the distribution and intensity of health services within the country, said that the reason for the increase in health expenditures is; They have emphasized that it is the quality of the population rather than the population density.

2.1.3 Increased Life Expectancy as a Factor Affecting Health Expenditures

Individuals and communities living a more organized life, technological advances, and growth in the pharmaceutical sector have been beneficial in extending life expectancy. On the other hand, the costs of care and treatment for the aging population increase in health expenditures (Yanar, 2011, p.24).

In the study on the determinants of health expenditures in OECD countries, it was found that population growth and the high average age of the population in countries have an undeniable importance on health expenditures. The main reason for the increased health

expenditures in developed countries is the elderly population in these countries (Kamacı & Yazıcı, 2017, p.55).

As a result, the longer the average life expectancy, the more favorable the economic growth performance will be in the long run. This is because the increase in the economic growth rate brings along an increase in income, leading to a rise in health expenditures and investments (Öner, 2018, p.25)

2.1.4 Urbanization, Improvement in Education and Health Awareness as Factors Affecting Health Expenditures

One of the most important results of economic development and industrialization is urbanization. Cities with different characteristics from rural areas; can be considered a cluster with a physical structure that includes technological and environmental order, social organizations consisting of institutions, and culture formed by different behaviors and thoughts (Karasu, 2008). Cities have more opportunities to access health services than rural areas (Moore, et al., 2003).

Urbanization, in its broadest sense, is the increase in the urban population and the number of cities in a country of industrialization and economic progress (Doğanay, 1997, p.426). In other words, economic development has a positive impact on urbanization. The increase in the number of health institutions in regions where urbanization is higher and the corresponding increase in the number of experienced employees will increase regional health expenditures. There is a danger of considerable losses in the event of an epidemic that may occur due to insufficient health investments (Akın, 2007, p.34).

The correlation between the urbanization variable and infant mortality was around 80% (negative correlation) in our sample. Since the urbanization variable has similar high correlations with other independent variables in our sample (e.g., gross domestic product, life expectancy, etc.). We do not include this variable in our analyses.

The increasing awareness of people over time also leads to an increase in expectations in demand for health services. For this reason, health tourism explains the expenditures on health. Health tourism is the travel of individuals who want to receive less costly, reliable, and highly pigmented medical or aesthetic services (Aydoğdu, 2016, p.12). In addition, countries, where health tourism is more developed will be preferred more. In this case, the contribution to the economy of the select country will be undeniable.

2.1.5 Technological Developments as a Factor Affecting Health Expenditures

Health technology is essential for the delivery, access, financing, and development of health services. Technological development in health services can be realized through various methods. For example, it can be the development of a new treatment modality, the production of a new medicine or medical device, and the adaptation of a technology already in use, such as magnetic resonance, to the health system. More broadly, drugs, vaccines, medical equipment, healthcare procedures (e.g., coronary artery bypass grafting), support systems, and the management systems that link all these different elements together are characterized as technology and are considered to be the primary driver of today's healthcare costs in more advanced societies as opposed to developing countries (Dybczak & Przywara, 2010, p.6).

- The mechanisms by which technological developments affect health expenditures can be explained as follows (Gelijns & Rosenberg, 1994, p.13);

- Intensity of use; New technologies have more benefits than current practices, and pressures against these technologies under conditions where third parties agree to cover the increased costs have an increasing effect on the intensity of use, which affects expenditures.
- Promotion of new or modified technologies; when new technologies are introduced, they are undeveloped and provide fewer benefits; continuous improvement is achieved by using feedback from those who use them to identify where improvements are needed. In the past, input on health technologies was mainly linked to clinical outcomes. Still, as the cost variable has become more critical, the demand for the development of cost-reducing technologies has led to increased scrutiny and the development of new and differentiated technologies.
- Widespread adoption has driven health technology innovations towards cost-reducing developments by providing incentives in various ways. Still, costs have risen as the use of these technologies has increased. For example, although modern imaging tools for imaging the brain avoid invasive procedures and potential risks, the increased use of this technology has offset the costs of diagnostic surgery and other interventions that are alternatives to the technology.

2.2 Impact of ICT Investment and Healthcare Expenditures

Information and Communication Technology (ICT) has the potential to bring about significant transformation in the healthcare industry, similar to its impact on other industries (Car & Sheikh, 2004a). Siau and Shen (2006) discuss that mobile communication is a revolutionary force that redefines how health information is managed in the healthcare industry and how communication takes place between physicians and patients. Health ICT can be seen as a tool to achieve improved

performance, transparency, and information sharing with health consumers (Brailer, 2007). According to Jensen and Aanestad (2007), hospital managers consider ICT to be an essential tool for effective information management and improved clinical practices. Solomon (2008) argue that ICT systems designed to support self-management can act as catalysts for transforming healthcare systems that may be unresponsive to the needs of a growing population. Collier (2010) notes that the widespread adoption of Electronic Health Records (EHRs) has the potential to enhance clinical research, best practices, outcome monitoring, resource planning, and adverse event tracking. Tang and Lansky (2005) agree with Collier (2010), stating that the widespread use of ICT is seen as a pathway to improving healthcare. Additionally, Collier (2010) argues that better ICT in healthcare can save time and reduce duplication of care.

Katic et al. (2007) suggested that ICT has the potential to revolutionize healthcare system management if tailored to the specific needs of the system. They further stated that the introduction of ICT systems in the healthcare industry has opened up possibilities for integrated and coordinated healthcare, as well as improved quality of care. Katic et al. (2007) also highlighted that the use of ICT, such as EHRs, in primary healthcare can facilitate the establishment of research databases. This viewpoint is supported by Susilo and Win (2007), who identified three benefits of centralized research databases, including facilitation of public health research, health services research, and clinical research.

Similarly, Katic et al. (2007) argued that research databases bring about benefits such as improved patient-oriented care, enhanced healthcare system functioning, and rational management of health resources.

It is widely recognized that Information and Communication Technology (ICT) systems, such as Personal Health Records (PHRs), have the potential to bring about significant changes in the health care industry. According to Grossman, Zayas-Cabán, and Kemper (2009), PHRs can enhance patient engagement, improve communication between patients and physicians, lead to better health outcomes, and reduce health costs. Tang and Lansky (2005) share the same perspective and agree with Grossman et al. (2009) that PHRs can facilitate new means of collaboration between patients and physicians, and serve as a foundation for widespread transformation in health care. Car and Sheikh (2004a) also support this view, comparing the potential impact of electronic communication in health care to its transformative effects in other industries like banking and retail. Tang and Lansky (2005) further emphasize that ICT systems like PHRs have the potential to revolutionize the patient-provider relationship in the 21st century. They recommend novel approaches to health system design that leverage ICT systems to enable patients to actively participate in their own care, fostering an uninterrupted healing relationship between patients and physicians.

The rising costs of health care are a significant concern in the global economy, and health care leaders are striving to reduce costs while maintaining high-quality care (Dogac & Kashyap, 2010; Schmidt & Altus, 2010). Information and Communication Technology (ICT) is being recognized as a key enabler for introducing efficiencies into the health care industry (Dogac & Kashyap, 2010). Effken and Abbott (2009) and Siau and Shen (2006) have stated that the use of web technology can help reduce the cost of health information sharing among health care providers and between patients and providers. Tate, Finkelstein, Khavjou, and Gustafson (2009) noted that delivering medical interventions over the Internet can be less expensive than face-to-face meetings with providers. Bhattacherjee et al. (2007), Terrell and Terrell (2009), and Wurster,

Lichtenstein, and Hogeboom (2009) also suggested that ICT has the potential to help contain health care expenditures. Powner (2005) explained that using ICT for administrative functions, clinical care, and public health infrastructure can generate cost savings.

Currie and Guah (2006), Bahensky et al. (2008), and Bhattacherjee et al. (2007) claimed that ICT can improve communication in the health care industry. Terrell and Terrell (2009) and Wurster et al. (2009) believed that ICT can help contain communication costs in health care. Car and Sheikh (2004a) argued that short electronic mail communication between physicians and patients, for example, could meet patients' needs more responsively and at lower costs.

Damberg et al. (2009) asserted that numerous studies have suggested that effective use of health ICT, such as computerized physician order entry, electronic health records (EHRs), and data exchange networks, can reduce health care expenditures. Powner (2005) argued that ICT systems have the potential to improve the efficiency and quality of health care, while also allowing for cost savings. Bahensky et al. (2008) also supported the argument that ICT has the potential to transform health care in terms of quality improvement and cost reduction.

According to Zaheer et al. 2020 in Impact of Information and Communication Technology (ICT) Investment on Different Components of Human Development in Developing Countries, ICT investment is the most important factor for human development in developing nations. The three main components of human development are the gross domestic product, health, and education. This study investigates the impact of ICT investment on the determinants of human development in 67 developing nations. On the basis of their income, selected emerging countries are categorized into four

panels: low, lower medium, higher middle, and high income. From 2000 to 2018, data were collected from the websites of the World Bank, ITU, and World Information Technology and Services Alliances. Pesaran, Friedman, and Frees CSD tests revealed the presence of cross-sectional dependence in the variables; hence, the CIPS second generation unit root test was employed to determine stationarity. The Kao and Pedroni test and the ARDL model were used to examine the long-term cointegration and regression, respectively. The regression results revealed contradictory conclusions in several panels. In four panels of developing nations, the results demonstrated that ICT investment has distinct effects on the determinants of human development. Investments in communication, software, and technology have a good effect on the components of human growth in each panel. Government is advised to prioritize ICT investment in order to boost GDP, level of education index, life expectancy index, and HDI. (Zaheer et al., 2020)

Unraveling the influence of investments in ICT, education, and health on development: an analysis of archival data from five West African countries using regression splines, according to Morawczynski et al. 2007. African countries have been investing in Information and Communication Technologies (ICTs) to promote development for more than a decade. Under the aegis of international development agencies such as the United Nations (UN) and the World Bank, these countries have been implementing technology plans aimed at providing 'digital chances' to all constituents, particularly the poor and those living in rural villages. These efforts have placed further pressure on national governments to invest human and financial resources in extending telecommunications infrastructure and training new users. Such efforts, however, have been criticized by others, who argue that underdeveloped countries should focus their limited financial resources on improving education or

healthcare. Others say that while ICT investments are important for development, they should be combined with other investments, such as education and healthcare. They use Multivariate Adaptive Regression Splines (MARS) to investigate the relationship between investments in ICT, education, and healthcare. They go on to look at how each investment class affects human development indicators in five West African countries: Benin, Cameroon, Senegal, Ivory Coast, and Niger. With such an approach, they demonstrate the interdependence of the three types of investments and argue that investments in ICTs alone are insufficient to meaningfully effect human growth. Complementary investments in education and healthcare must be considered equally. (Morawczynski et al. 2007)

Ngwenyama et al. (2006) examine the association between investments in ICT, Healthcare, and Education and social and economic development in five West African nations. Between 1997 and 2003, the five countries under examination are Benin, Cameroon, the Ivory Coast, Senegal, and Niger. They utilize archive data produced by the United Nations, UNDP, and ITU. They utilize the UN Human Growth Index HDI (its component indices) as a measure of these countries' social and economic development (Hick & Streeten, 1979; Mahlberg & Obersteiner, 2001). The UN calculates the HDI as an evaluation of the prevailing social and economic conditions in each country. Although there have been debates regarding the precision of this index, it is currently the preferred method for understanding and measuring this complex reality of social and economic growth (Depotis, 2005, Neumayer, 2001). This study is intrigued by the HDI's component scores for knowledge, lifespan, and level of living. They analyze the links between investments in ICT, Health Care, and Education and the human development index in five West African countries. Ngwenyama et al. (2006) employ a Stepwise regression analysis to assist in elucidating the intricate correlations

between these variables. Results demonstrate that complementing expenditures in ICT, health, and education can substantially boost development. Given that developing nations are making substantial expenditures in healthcare, education, and ICT, and that there are concerns about the types of investments they should make, their findings represent a substantial contribution to the literature. (Ngwenyama et al., 2006)

The impact of ICT, healthcare investment, and eHealth policy in accomplishing Millennium Development Goals: a cross-country comparison, according to Irawan et al. This paper offers a country-level assessment of the impact of ICT level development, healthcare spending, and the adoption of an eHealth strategy on public health outcomes, notably Infant and Maternal Mortality rate (IMR & MMR), a crucial component of the Millennium Development Goals. As one of the few large sample studies linking ICT and public health, we supplement empirical results from existing case studies and provide interesting insights into how the effects of ICT level development, healthcare expenditures, and eHealth policy establishment on these health outcomes are not independent, but dependent on one another. We extracted the data utilized in this analysis from a variety of publicly available data sources. WHO research data and the Global Observatory for eHealth were used for health indicator data (WHO, 2020). The ITU (International Telecommunication Union) database was used to derive ICT-related measures (WHO, 2020). Some data are not accessible for all years, and the resultant 75-country panel dataset for study spans the years 2005-2012. Analysis of panel data analyzes variables across a set of observations throughout time. In this study, the level of analysis is country-year, which means that they track the values of indicators for various countries over a certain time period (Irawan et al., 2006).

The literature study demonstrates that numerous studies on ICT investment have been conducted. It will assist us in comprehending the aspects that affect the cost of

ICT expenditures in the healthcare industry. This is the first study to analyze the influence of ICT expenditures on the cost of ICT expenditures in the health sector of seven industrialized nations utilizing annual data collected between 2000 and 2019 using the panel data analysis method.

2.3 Impact of Inflation and Exchange Rate on Healthcare Expenditures

Exchange rate fluctuations and high inflation rates can also impact healthcare ICT investment. For example, when the local currency weakens against foreign currencies or when inflation rates are high, it can increase the cost of ICT infrastructure, software, and other technologies needed for healthcare delivery, leading to reduced ICT investment in healthcare (World Bank, 2019). On the other hand, when the local currency strengthens against foreign currencies or when inflation rates are low, it can potentially lower the cost of ICT investment in healthcare, leading to increased ICT adoption and utilization in the healthcare sector.

2.3.1 Impact of Inflation

Research assessing Turkey's CPI and subcomponents has discovered a relationship between health inflation and overall inflation (Öner, 2018). Two studies examine the relationship between health expenditures and inflation. Taşkaya and Demirkan's 2016 study investigated the link between health expenditures, GDP per capita, and inflation rate. According to the study's findings based on data from 1975 to 2013, there was no causal relationship between the three factors (Taskaya & Demirkan, 2016). Using data from 2003 to 2016, Turgut, et al. (2017) investigated the link between health

expenditures and inflation. The study shows a positive and significant relationship between the inflation rate and health expenditures (Turgut et al., 2017).

Health market assessments of price control regulations in a country focus on the causes of health care inflation and the effects of inflationary increases on health expenditures and the health care system (Virts and Wilson, 1984: 90). However, it is noticed that the majority of research on health system efficiency focuses on the impact of per capita income (Dhaoui, 2019, p.6) and ignores a significant macroeconomic factor such as the inflation rate.

Newhouse (1977) conducted the first research to assess the link between income and expenditure (Newhouse, 1977). For a long time, the subsequent analysis focused only on the relationship between income and health expenditure (Hartwig & Sturm, 2014). However, money is not the only factor affecting health costs (Ücdoğruk, 1996) In economic terms; the inflation rate is another factor affecting health expenditures (Dhoro et al., 2011; Boachie et al., 2014). "Inflation rate" refers to the general increase in the prices of goods and services. As inflation increases, the purchasing power of individuals decreases. As a result of the rise in the cost of goods and services, it is known that consumers change their purchasing decisions and give up their demand for non-urgent health treatment to maximize marginal utility (Hildebrandt & Thomas, 1991). This situation negatively affects the national health cost.

One of the critical factors affecting health expenditures is the changes in the inflation rate, which is used as a control variable in our research. According to the research results, health expenditures are limited due to increasing inflation; health services and quality are negatively affected. Monea (2014) states that the most important reasons for cost inflation and expenditure increase in health and services in

the US are the lack of transparency in purchasing and unnecessary purchases and argues that policymakers should focus on unnecessary expenditures to ensure efficiency in health expenditures. Feliciano et al. (2017) show a strong negative correlation between Brazil's inflation rate and financing and expenditure variables. According to the results of the study, policies implemented in line with monetary policy and within the framework of the inflation target limit the financing of health. According to Taşkaya and Demirkıran (2016), the increase in the prices of goods and services affects the change in individuals' demand for health services. According to the study, individuals give up their non-urgent health service demands in an inflationary environment. On the other hand, Artan et al. (2017), in a survey conducted on BRICS countries between 2000 and 2013, found a negative relationship between unemployment and inflation, investment expenditures and corruption, and productivity in the health sector. Turgut et al. (2017) show a statistically significant and positive relationship between total health expenditures and inflation in Turkey from 2003-2016.

In the broadest sense, inflation is defined as a continuous increase in the general level of prices. The price index measures the general price level included in the definition of inflation. The price index can be calculated in two ways: consumer price index and producer price index (Ünsal, 2011, p.80-83).

Numerous variables affect inflation, including money supply, exchange rate, and Gross Domestic Product (GDP) expansion (Korkmaz, 2017, p.116). Health expenditures are another one of these variables. Studies show that health expenditures affect inflation (Hartwig & Sturm, 2014; Newhouse, 1977), and inflation affects health expenditures (Dhoro et al., 2011). This study investigates the relationship between health expenditures and inflation.

Health inflation is higher than general inflation due to the distinctive features of the health system (Charlesworth, 2014). As a result of current technical advances, there have been various developments, such as pharmaceuticals, magnetic resonance imaging (MRI) scanners, critical care medicine, etc. These advances in modern medicine have led to increased health service prices and, thus, to significant health inflation and health expenditures (Pentecost, 2004, p.901). In addition, population growth, changes in population structure, health insurance coverage, and increases in per capita health expenditures contribute to the rise in the CPI of the health sector (Cherne & Newhouse, 2012). The increase in health sector CPI and health expenditures can have severe economic impacts on countries.

According to a review of the worldwide literature, there is research examining the link between health inflation and general inflation. According to a study conducted by Bayati et al. (2014) hospitalization services and medical costs significantly impact health inflation (Bayati et al., 2014). According to the second Iranian study, the relationship between health inflation and general inflation is positive. Still, the relationship between health inflation and the number of beds and doctors per 1000 people is negative (Teimouriza et al., 2014).

During the 2000s, healthcare expenditures increased quickly for several years. The price of pharmaceuticals, medical devices, and hospital treatment increased between 2000 and 2011, accounting for 91% of the growth in healthcare costs, according to the November 2013 issue of the Journal of the American Medical Association (JAMA) (Patton, 2015).

For several years, the U.S. health spending growth rate has surpassed the country's GDP, inflation, and population growth rates. Actual health spending per capita

increased annually between 1940 and 1990 at a pace that varied from 3.6% in the 1960s to 6.5% in the 1990s. In parallel, the percentage of GDP that health spending accounted for increased from 4.5% in 1940 to 12.2% in 1990. (ASPE, 2007).

Concerns regarding the damaging effects of healthcare cost inflation on the U.S. economy have been expressed in light of the sharp growth in health spending and the percentage of GDP devoted to healthcare. The main worry is that acute increases in health spending could impact important economic metrics, including per capita GDP, employment, and inflation. Governments, corporations, consumers, and all other sectors of the economy are likely to feel the effects (ASPE, 2007). This study examined whether rising healthcare costs in Turkey impact inflation.

The cost of healthcare varies significantly between nations and over time within countries. Different demographics, life expectancy, infant mortality, socioeconomic environments, and healthcare system structures have been implicated as the cause of the discrepancy between nations (Payne et al., 2015).

Studies primarily focus on analyzing the relationship between health expenses and income (Balcha, 2014; Caporale et al., 2015; Newhouse, 1977; Moscone & Tosetti, 2010; Baltagi & Moscone, 2010; Sghari & Hammami, 2013). The inflation rate is another factor that may impact health expenses. Therefore, income is not the only factor determining health spending (Hartwig & Sturm, 2014; Newhouse, 1977; Russell, 1975).

When the international literature is looked at, it can be observed that numerous studies are looking into health expenditures and factors that affect them, such as income, per capita health expenditure, and GDP (Boachie et al., 2014; Dhoro et al.,

2011; Hartwig & Sturm, 2014; Moscone & Tosetti, 2010; Newhouse, 1977; Russell, 1975).

According to a 2011 study by Dhoro et al. on the drivers of public health care spending in Zimbabwe, income (per capita GDP), per capita foreign health aid, literacy rate, and inflation rate all have a significant role in explaining public health care spending. Additionally, it indicates that public expenditure on healthcare is less responsive to changes in the inflation rate. On the other hand, the cost of public health care is significantly but unfavorably impacted by the inflation rate.

According to a study by Boachie et al. (2014) that looked at the factors influencing public healthcare spending in Ghana, real GDP, life expectancy, and crude birth rate were the main factors. Another crucial factor that favorably affects public healthcare spending is real GDP. The percentage and age of the population living in rural areas, inflation, and the positive symptoms of pollution are crucial elements to observe when determining public health expenditures, even though their findings are not statistically significant. The long-term impact of inflation on public health spending in Ghana is negligible.

In Turkey, there are few research that examines the relationship between health expenditures and the factors that influence these expenses (Ak, 2012; Akar, 2014; Cetin and Ecevit, 2010; Kiymaz, Akbulut and Demir, 2006; Sulku & Caner, 2009; Kurt, 2015; Taskaya & Demirkiran, 2016). These studies examine economic growth and health spending (per capita and GDP).

The correlation between Turkish inflation and health spending has only been examined in one study. In their 2016 study, Taskaya and Demirkiran sought to ascertain the correlation between Turkey's GDP, GDP per capita, and inflation rate. To examine

the causal relationship between variables, data for 1975 through 2013 were acquired from the World Bank Databases and the OECD Health Data, 2015 Granger technique. As a result, there is no connection between GDP per capita, inflation rate, and GDP's share of health expenditures. GDP was the only factor that was impacted by inflation.

The link between inflation and health expenditures is vital for the economy. Accordingly, one of the other objectives of this study is to determine whether there is a relationship between the rate of change in health expenditures and the inflation rate.

2.3.2 Impact of Exchange Rate

Unaffected by exchange rates or purchasing power parities (PPPs), simple regression analysis (cross-sectional and pooling time series) has demonstrated that the GDP per capita explains a considerable proportion of the variation in total per capita health expenditures. (O'Connel, 1996; Hitiris, 1992; O'Connel, 1997; Newhouse, 1977; OECD, 1987; Parkin, 1987; Parkin, 1989; O'Connel, 1996)

Multivariate cross-sectional and time series analyses have shown comparable results about GDP. In all models examined, Kleiman's (1974) landmark cross-sectional multivariate study revealed a positive correlation between GDP in terms of exchange rates and overall health expenditures. Later cross-sectional analyses utilizing exchange rates (OECD, 1985; Leu, 1986; Getzen, 1992; Gerdtham & Jonsson, 1991) and PPPs (OECD, 1985; Pfaff, 1990; Gerdtham & Jonsson, 1991; Gerdtham et al., 1992; Getzen, 1992; Murillo, Piatecki & Saez, 1993) supported this.

Multivariate time series analysis has produced less consistent outcomes. Using data from three nations, Pfaff (1990) verified the positive association between GDP and total per capita health expenditures for Canada and the United States but not for Germany.

The relationship became negative but was not statistically significant. Kanavos and Yfantopoulos (1999) discovered that the GDP lacked considerable explanatory power in seven of the fourteen European Union member states, regardless of the measurement of exchange rates, PPPs, or national currencies.

In international studies that examine the relationship between the relevant variables, studies that find a positive relationship are predominant. Narayan and Mishra (2010) in their research on 5 Asian countries, Bakare and Olukobun (2011) in their analysis on Nigeria, Selim et al. (2014) in their study on 27 European Union countries and Turkey, Hayaloğlu and Bal (2015) in their research on 54 upper-middle income countries, Yıldız B. and Yıldız G. (2018) in their studies on European and Central Asian countries, Kılıç and Beşer (2018) in their analysis on Central and Eastern European Countries, Dinçer and Yüksel (2019) in their research for E7 Countries, Wang et al. (2019) in their study on Pakistan concluded that health expenditures positively affect economic growth. In international studies, some studies find no positive relationship between the relevant variables. These are Akram et al. (2008), in their analysis of Pakistan, Ogundipe and Lawal (2011) found no significant relationship between health expenditures and economic growth in their study on Nigeria.

Within the framework of these analyzes and different results in the literature, Çınar and Has's (2021) study examines the relationship between health expenditures and economic growth in the long run. In this framework, the primary purpose of the analysis is to analyze the impact of the health sector on economic development within the framework of econometric methods by including the exchange rate in the model and taking into account the structural breaks between 1975-2019. (Çınar & Has, 2021) Foreign dependency in the health sector is an undeniable fact. In particular, there is 54% foreign dependency in the pharmaceutical industry, 82% in the materials used in

the health sector, 84% in the devices used in health, and nearly 100% in vaccines. As of 2018, Turkey imports from the world's ten largest pharmaceutical companies in the pharmaceutical industry, which has an important place in health expenditures. In particular, US Pfizer, Swiss Roche, and French Sanofi are in the top three in this regard. Changes in the exchange rate are significant for the health sector (Özden & Ersan, 2019, p.10).

In this context, the exchange rate was added to the model since imported inputs are intensive in the health sector. The study was carried out because the analysis would provide more accurate results. Accordingly, another objective of this study is to determine whether there is a relationship between the rate of change in health expenditures and changes in the exchange rate.

As a result, a literature review reveals that many studies have been conducted on health expenditures. Investments are frequently analyzed depending on health expenditures, inflation studies, economic growth, and technological innovations. Moreover, it has been observed that studies have generally focused on health expenditure, gross domestic product per capita, and economic growth, while other economic variables have been ignored. This study will help us understand the variables affecting health expenditures. In this framework, this study makes an essential contribution to the literature as it is the study that analyzes the relationship between the variables in 2000-2019 with the most recent data, examines by taking into account explores the health sector by taking into account the inflation rate and exchange rate, which are of great importance in terms of finance. This study differs from other studies in the literature as it is the first to investigate the effect of changes in inflation rate and exchange rates on health expenditures in G20 countries by using annual data between 2000-2019 using the panel data analysis method.

CHAPTER 3

SAMPLE AND METHODOLOGY

3.1 Sample

In order to examine the relationship between health expenditures, which is an important component of human capital in G20 countries, and two important financial indicators, exchange rate and inflation rate, this study utilizes G20 or Group of Twenty countries outside the European Union (EU). These are especially Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. The data were sourced from the database World Development Indicators of the World Bank (2022). Due to limitation of data availability, the scope of the study spans the period from 2000 through 2019. This is because not all of the data requested for each country is available in the wider sample period, and some countries did not share data during Covid19.

Due to data limitations on ICT investments in the health sector, we use 7 of the G20 countries in order to study the relationship between health expenditures and ICT investments in the health sector. These are Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America. The scope of the study spans the period from 2000 through 2019. Our sample period ends by 2020 since most of the countries did not share data during the Covid19 pandemic period starting 2020.

Variables used in this study are provided below along with the abbreviations used for each variable. All data is annual and were sourced from the database World

Development Indicators of the World Bank (2022). For only the data on Tax revenue as a percentage of GDP , some countries (Australia, Canada, France, Germany, Italy, Japan, The Republic of Korea, Republic of, Mexico, Turkey, The United Kingdom and The United States of America) data were obtained from the OECD database (2022) and some countries (Argentina, Brazil, China, India, Indonesia, Russian Federation, Saudi Arabia, South Africa) data were acquired from the database World Development Indicators of the World Bank (2022).

- CHEPC: Current health expenditure per capita that includes "(all) Current expenditures on health per capita in current US dollars. Estimates of current health expenditures include healthcare goods and services consumed during each year" (World Bank Database definition). Its logarithmic transformation is used in analyses.
- DGHEPC: Domestic general government health expenditure per capita that includes "(Government) Public expenditure on health from domestic sources per capita expressed in current US dollars" (World Bank Database definition). Its logarithmic transformation is used in analyses.
- DPHEPC: Domestic private health expenditure per capita that includes "current private expenditures on health per capita expressed in current US dollars. Domestic private sources include funds from households, corporations and non-profit organizations. Such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers" (World Bank Database definition). Its logarithmic transformation is used in analyses.
- OOPEPC: Out-of-pocket expenditure per capita that includes "Health expenditure through out-of-pocket payments per capita in USD. Out of pocket payments are spending on health directly out of pocket by households in each

country” (World Bank Database definition). Its logarithmic transformation is used in analyses.

- ELDER: Percentage of the total population with ages 65 and above.
- EXC: Exchange rate between Local Currency and US Dollars in terms of USD.
- GDP: Gross Domestic Product (in current US Dollars). Its logarithmic transformation is used in analyses.
- GGFCE: General government final consumption expenditure as percentage of Gross Domestic Product.
- ICTBYHEALTH: Information and Communication Technology Investment by Health Sector (in current US Dollars). Its logarithmic transformation is used in analyses.
- IMORT: Number of infant deaths. Its logarithmic transformation is used in analyses.
- INF: Inflation, consumer prices (annual %) based on consumer price index.
- LIFE: Life expectancy. Its logarithmic transformation is used in analyses.
- POP: Population. Its logarithmic transformation is used in analyses.
- RD: Research and development expenditure as percentage of Gross Domestic Product.
- TAX: Tax revenue as percentage of Gross Domestic Product.

3.2 Methodology

For both research topics in this study, the stationarity of the series will be analyzed using a panel unit root test, and the series will be adjusted accordingly. Next, panel data regressions will be estimated. "EViews" is used for the analysis.

In studies using panel data, the analysis framework changes as the time dimension (T) increases relative to the unit size (N). This is because the asymptotic distributions of macro panel (N and T large) analyses differ from those of micro panel (N large, T small) analyses in panel data econometrics. Generating macro panel data brings two issues to the fore as the time dimension of panel data increases towards infinity. The first one is the rejection of the homogeneity of regression parameters when using the regression model. Studies in this framework argue that the regression model of each unit should be estimated separately as T increases (Verbeek, 2004, p. 369.)

These arguments suggest that if regression models such as fixed effects models continue to be used, the parameters will contain a large amount of bias (trend) due to parameter heterogeneity arising from the difference between units and the serial correlation of the regressors. Secondly, they argue that if T increases, there may be spurious regression due to the non-stationarity of the variables. Therefore, panel regression techniques should be combined with time series techniques. In this framework, extending the logic of time series analysis to panel data means that unit root tests will also be applied to panel series. If panel data are both heterogeneous and non-stationary, econometric techniques can overcome these problems.

In the empirical analysis, the Levin, Lin, and Chu (2002) test is used.

Static panel data models are data models in which lagged values of both the dependent and independent variables are not used to explain the dependent variable. The most basic static data model is the classical linear regression model. In order to obtain consistent forecasts by applying classical regression analysis in panel data analysis, the absence of a relationship between independent variables and errors is one of the conditions (Beck, 2006: 2).

The panel data model can be presented in its most basic form as follows:

$$Y_{it} = X_{it}\beta + z'_i\alpha + s'_i\gamma + \varepsilon_{it} \qquad i = 1,2,\dots N \qquad t = 1,2,\dots T \qquad (3.1)$$

i denotes horizontal cross-sections, and t represents time. The X_{it} matrix without constant term contains K explanatory variables. The variables $z'_i\alpha$ and $s'_t\gamma$ in the model indicate heterogeneity. The $z'_i\alpha$ variable also shows the differences between horizontal cross-sections. This is called personal effects. The variable z'_i is the constant term. The $s'_t\gamma$ variable shows the period differences of the model in the time series dimension. If the variables indicating heterogeneity in the model are shown as $z'_i\alpha = \mu i$ and $s'_t\gamma = \lambda t$, the model can be organized as follows;

$$Y_{it} = X_{it}\beta + \mu_i + \lambda_t + \varepsilon_{it} \quad (3.2)$$

Static panel models can be broadly classified into two main categories: fixed effects, and random effects, depending on whether the coefficients are assumed to be fixed or random.

First, we will apply unit root tests to ensure stationary forms of variables are used in regressions. Unit Root Tests, the Unit root concept, is a process that is closely related to stationarity. When a series has a unit root, the series has a non-stationary process (Göktaş, 2005). The fact that the estimated model contains a unit-rooted process indicates that the results are insignificant. Therefore, a unit root test should be performed on the series before starting any study (Gujarati, 2012:754). The concept of unit root is one of the leading methods used to test the stationarity of tests. The presence or absence of a unit root in the analyzed series enables the determination of stationarity. In order to ensure stationarity in the series, different methods are used by first taking the differences of the series in logarithms and then taking the first differences of the

logarithms. If a non-stationary time series becomes stationary after it is differenced "d" times, it is integrated into the dth order and expressed as I (d) (Göktaş, 2005).

In autoregressive models, it is essential to analyze whether the time series is stationary. If a time series has a unit root, the series is non-stationary, and its movements cannot be predicted. In this case, instead of using the time series (yt) directly in regression analysis, the series constructed from its first differences (dyt) is used.

Whether a time series has a unit root, i.e., whether it is stationary or not, is determined by using unit root tests. We use Levin, Lin, and Chu (2002) panel data unit root test (denoted as LLC) since we have a balanced panel set. Table 1 shows the results of Levin, Lin, and Chu (2002) panel unit root tests for all variables.

Table 1

Unit Root Tests, G-20 Countries, 2000-2019

Variables	Description	Level	First Difference
CHEPC	Current health expenditure per capita (current US$)	-6,08175 ***	-6,72966 ***
DGHEPC	Domestic general government health expenditure per capita (current US$)	-6,883 ***	-6,41972 ***
DPHEPC	Domestic private (corporations, non-government non-profit organization, households) health expenditure per capita (current US$)	-5,27943 ***	-7,2321 ***
OOPEPC	Per capita out-of-pocket expenditures by households (current US$)	-5,77069 ***	-6,39916 ***
EXC	Exchange rate between Local Currency and US Dollars (in terms of USD).	-1,91568 **	-28,3147 ***
GDP	GDP per capita (current US$)	-6,27885 ***	-8,24962 ***
GGFCE	General government final consumption expenditure as percentage of GDP (%)	-1,64058 **	-8,06583 ***
IMORT	Number of infant death	0,49908	-18,8095 ***
INF	Inflation, consumer prices (annual %) based on consumer price index (%)	-6,73587 ***	-13,2802 ***
LIFE	Life expectancy	-11,927 ***	-9,345 ***
ELDER	Percentage of total population with age 65 and above (%)	2,80203	-1,68868 **
POP	Population	-4,3714 ***	-3,60365 ***
TAX	Tax revenue as percentage of GDP (%)	-2,13258 **	-8,65247 ***
RD	Research and development expenditure as percentage of GDP (%)	1,03859	-5,14544 ***
ICTBYHEALTH	Information and Communication Technology Investment by Health Sector (current US$)	-4,78289 ***	-2,25489 **

The test statistics from Levin, Lin, and Chu (2002) panel unit root tests are reported for 19 G20 countries including Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America during 2000-2019. ICTBYHEALTH variable is calculated only 7 of the 19 G20 countries (Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America) due to data limitation. All data is annual and obtained from the World Development Indicators database of the World Bank (2022). Data other than those denoted as percentages are transformed to logarithm form. ***, ** and * denote significance at 1%, 5% and 10%, respectively. *Source*: Authors' computation (2023).

A unit root test was conducted for 15 different variables of G20 countries for the period 2000-2019 (Table 1). This analysis was performed using the EViews program. As a result of this test, we want all variables to be stationary. Accordingly, LLC unit root tests were performed for each variable. Table 1 shows the results. A panel unit root test was also conducted for the subsample of 7 countries that have ICT investment data, and the results for similar to those of main sample shown in Table 1. We use first differences of all variables in panel regressions except for one: The inflation variable, which shows the periodic change consumer prices over time, was kept at level. Thus, all our variables represent the periodic change over time.

Then, based on the results from the Hausman test (Green, 2003), we decide whether to apply fixed or random effects model for our panel data regressions to examine the relationships of health expenditures with ICT investments by health sector as well as with inflation, and exchange rate. We will use panel corrected standard error to eliminate heteroscedasticity and correlation (Beck & Katz, 1995).

3.2.1 Fixed Effects Model

In a regression analysis, if some coefficients are allowed to vary across units and/or time, the regression coefficients become unknown but constant parameters. In the literature, such models are called fixed effects models where the slope coefficients between cross-sections are the same and the constant coefficient varies.

One way to identify individual characteristics in a panel data model is to relax the assumption that all individuals have the same coefficients. For this purpose, the fixed effects model includes as many different terms as the number of individuals, one for each individual (Yılancı, 2012: 14).

In fixed effects models, if only differences between units are considered, it is called a "One-Way Fixed Effects Model," and if differences between units and time are considered, it is called a "Two-Way Fixed Effects Model" (Sayyan, 2000, p. 20).

The term fixed effects here come from the fact that although the constant is different for each cross-section, the constant of each cross-section does not change over time (time-invariant). In this model, the slope coefficients are the same for both time and cross-section.

It is a fixed effects model in which the slope coefficients in a model are the same for time and cross-sectional units, but as Greene (2003, p. 469) states, the coefficient changes according to horizontal cross-sectional units. This model is also called the dummy variable model because the panel data model is explained with a dummy variable. In addition, differences between cross-sectional units are used to explain the constant terms in the model.

In general, when panel data is considered;

$$Y_{it} = \beta_{0it} + \beta_{1it}X_{1it} + \beta_{2it}X_{2it} + \cdots .. + \beta_{jit}X_{jit} + \varepsilon_{it} \;\; i = 1,2, \ldots N \quad t = 1,2, \ldots T \qquad (3.4)$$

In this model, xit is assumed to be independent of ε_{it} and $\varepsilon_{it} \sim iid\ (0,\sigma^2)$. Note that the slope coefficient β is constant across time and individuals, while the constant term is α_i is constant across time but varies across individuals.

In the fixed effect model,

$$\beta_{0it} = \beta_{0i} = \beta + \varepsilon_i \; ; \qquad \beta_{1it} = \beta_1; \quad \beta_{2it} = \beta_1, \ldots\ldots\ldots , \; \beta_{jit} = \beta_j \qquad (3.5)$$

is assumed to be constant over time.

ε_i ; denotes unit effects that are constant over time, while ε_{it}; denotes the error term. Since it includes the unit effect, only the constant parameter changes; it is constant over time but varies across units.

3.2.2 Random Effects Model

Despite the extensive use of the fixed effects model, the large number of horizontal cross-sections involved (due to the use of dummy variables) leads to a loss of degrees of freedom. The reason for using the fixed effects model is that the model fails to include time-invariant relevant explanatory variables in the identification of the model, and the inclusion of dummy variables in the model covers this ignorance. If dummy variables do not actually provide information about the correct model, why is this lack of information not expressed through the error term? For this, the random effects model is proposed. In the random effects model, cross-sectional and/or time-dependent changes are called a component of the error term in the model. This is because the degree of freedom that we encounter in the fixed effects model disappears in the random effects model (Baltagi, 2005, p. 15).

If the individual effects in the model cannot explain the explanatory variables and the constant terms of the units are randomly distributed with each other, the configuration of the model should be adjusted accordingly (Greene, 2003, p. 293). When the units selected in the model are randomly selected, the differences between units will also be random. The unit differences here are called "random differences." In regression analyses, it is generally assumed that there are many factors that affect the value of the dependent variable but are not included in the model as independent variables and that these factors are summarized by a random residual.

General panel data equation;

$$Y_{it} = \beta_{0it} + \beta_{1it}X_{1it} + \beta_{2it}X_{2it} + \cdots .. + \beta_{jit}X_{jit} + \varepsilon_{it} \;\; i = 1,2, \ldots N \quad t = 1,2, \ldots T \quad (3.6)$$

Error term of the random effects model (ε_{it}),

$$\varepsilon_{it} = v_{it} + \mu_i \quad (3.7)$$

random effects model;

$$Y_{it} = \beta_{0it} + \beta_{1it}X_{1it} + \beta_{2it}X_{2it} + \cdots + \beta_{jit}X_{jit} + v_{it} + \mu_i \quad (3.8)$$

is in the form. μi is expressed in the error term since it is assumed to be random rather than constant. μ_i shows the unit error, unit differences, and the variation between units with respect to a fixed time while v_{it} represents all errors. In the random effects model, the first type of variables are expressed as ε_{it} , while the unit effects of the second type of variables are expressed as ε_i. The random effects model is also called the "error components model" or "variance components model."

CHAPTER 4

EMPIRICAL RESULTS: IMPACT OF HEALTH SECTOR ICT INVESTMENTS ON HEALTHCARE EXPENDITURES

In this section, we examine the role of ICT investments in the health sector on health expenditures in 7 major G20 countries. Only seven of G20 countries report historical data on ICT Investments in health sector during our ample period of 2000-2019: Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America. Our sample period ends in 2019 because most of the countries did not share data during the Covid19 pandemic period starting 2020.

We use 4 alternative measures of health expenditures, which is the dependent variable in our panel data regressions:

1. Domestic private health expenditure per capita (current US$) denoted as DPHEPC representing the **c**urrent private expenditures on health per capita expressed in current US dollars where domestic private sources include funds from households, corporations and non-profit organizations and such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers.
2. Current health expenditure per capita (current US$) denotes as CHEPC where all current expenditures on healthcare goods and services consumed during each year per capita in current US dollars.
3. Domestic general government health expenditure per capita (current US$) denoted as DGHEPC.

4. Out-of-pocket expenditure per capita (current US$) denoted as OOPEPC representing out of pocket payments are spending on health directly out of pocket by households in each country.

We examine the relationship between each of these alternative health expenditure measure with health sector ICT investment denoted as ICTBYHEALTH. The control variables used are population (denoted as POP), life expectancy (LIFE), gross domestic product (GDP) per capita, inflation rate (INF), percentage of total population with age 65 or older (ELDER), tax revenue (TAX), research and development expenditure (RD) and total government fiscal expenditure (GGFCE) as percentages of GDP. Among the seven countries for which we could obtain historical data for ICT investment of health sector, infant immortality rates were very low and similar, and there is a high correlation between exchange rate and GDP. Therefore, we exclude the infant mortality rate and exchange rate variables from the regressions examining the relationship between health expenditure with health sector ICT investment.

Table 2 presents descriptive statistics for all of the variables. As Table 2 shows, there are no large standard deviations and we do not observe any extreme fluctuations in variables over time. Table 3 has the cross-correlation results. As Table 3 presents there are no strong correlations among independent variables in our sample of 7 G20 countries during the period of 2000-2019.

Table 2

Descriptive Statistics – ICT Investment by Health Sector Sample, 2000-2019

Variables	Description	Mean	Median	SD	Max.	Min.	Obs.
CHEPC	Current health expenditure per capita (current US$)	8.28110	8.33459	0.41448	9.29844	7.32925	140
DGHEPC	Domestic general government health expenditure per capita (current US$)	7.93213	8.03374	0.34111	8.62202	7.00957	140
DPHEPC	Domestic private health expenditure per capita (current US$)	6.96881	6.77163	0.65338	8.58829	5.99811	140
ELDER	Percentage of total population with age 65 and above (%)	0.17008	0.16400	0.03690	0.28002	0.12278	140
GDP	GDP per capita (current US$)	10.58154	10.61222	0.26456	11.12956	9.87957	140
GGFCE	General government final consumption expenditure as percentage of GDP (%)	0.19163	0.19163	0.02467	0.24126	0.13915	140
ICTBYHEALTH	Information and Communication Technology Investment by Health Sector (current US$)	7.68014	7.34091	0.97318	9.84252	6.23537	140
INF	Inflation, consumer prices (annual %) based on consumer price index (%)	0.01713	0.01821	0.01156	0.04457	-0.01353	140
LIFE	Life expectancy	4.39274	4.39729	0.02201	4.43505	4.33908	140
OOPEPC	Per capita out-of-pocket expenditures by households (current US$)	6.38325	6.43170	0.40464	7.11910	5.05779	140
POP	Population	18.03865	17.93586	0.80280	19.60953	16.76797	140
RD	Research and development expenditure as percentage of GDP (%)	0.02100	0.02018	0.00628	0.03368	0.01004	140
TAX	Tax revenue as percentage of GDP (%)	0.24964	0.26751	0.04681	0.30778	0.14829	140

Data other than those denoted as percentages (%) are transformed to logarithm form. ICT Investment by Health Sector Sample includes data for Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America. SD denotes standard deviation; Max. is maximum; Min. represents minimum; Obs. is number of observations.

Source: Authors' computation (2023)

Table 3

Correlation Matrix– ICT Investment by Health Sector Sample, 2000-2019

Variables	ELDER	GDP	GGFCE	ICTBYHEALTH	INF	LIFE	POP	RD	TAX
ELDER	1.00000	-0.27646	-0.12225	-0.25537	-0.58731	-0.16867	-0.44844	-0.05867	0.25342
GDP		1.00000	-0.23278	0.47608	0.31398	0.13773	0.11994	-0.10506	-0.03986
GGFCE			1.00000	-0.06753	-0.17850	0.06732	0.03226	0.12295	-0.34749
ICTBYHEALTH				1.00000	0.18496	0.04519	0.00418	0.04551	-0.01023
INF					1.00000	0.09256	0.51551	0.08666	-0.01216
LIFE						1.00000	0.03699	0.04595	-0.03036
POP							1.00000	-0.11399	-0.15544
RD								1.00000	-0.05498
TAX									1.00000

ICT Investment by Health Sector Sample includes data for Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America. Correlation coefficients between independent variables are reported. ELDER is total population with age 65 and above (%); GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Data other than those described as percentages (%) are transformed to logarithm form.

Source: Authors' computation (2023)

Based on the Hausman test (Green, 2003) results, and because number of countries is smaller than number of parameters in the regression (Eviews 12), we use fixed effects model for our panel data regressions to examine the relationships of health expenditures with ICT investments by health sector. All variables used represents the periodic change in that variable, except the inflation variable, which is itself shows the periodic change in consumer prices. Our unit root analysis based on the Levin, Lin, and Chu (2002) confirms that variables used in regressions are stationary.

We estimate four main sets of equations for each alternative health expenditure measure (i.e., Domestic private health expenditure per capita, Domestic general government health expenditure per capita, Current health expenditure per capita, and Out-of-pocket expenditure per capita), each with two different specifications, with and without the ICTBYHEALTH variable. This is done to avoid spurious estimates. Table 4 shows results from these panel fixed effect regressions. Table 4 has a total of 8 columns illustrating the 8 specifications.

The empirical results from the fixed panel regressions for the 7 G-20 countries during the period of 2000-2019 can be summarized as follows:

a) The growth in the elder population percentage in overall population is negatively related to the growth in total per capita private health expenditures representing the sum of expenditures by households, corporations and non-profit organizations.

b) The growth in the elder population percentage in overall population is negatively related to the growth in household out of pocket health expenditures per capita.

c) The primary determinants of per capita current health expenditure including healthcare goods and services consumed each year are the growth in gross domestic

product and the growth in the weight of total government fiscal expenditures in gross domestic product.

d) The primary determinants of per capita government health expenditure are the growth in gross domestic product and the growth in the weight of total government fiscal expenditures in gross domestic product.

e) The primary determinants of per capita health expenditures by total private sector including households, corporations and non-profit organizations are the growth in gross domestic product and the growth in relative weight of people with age 65 or above in population.

f) The primary determinants of per capita household health expenditures are the growth in gross domestic product and the growth in relative weight of people with age 65 or above in population.

g) Health sector investment in information and communication technologies is a significant determinant for household and total private health expenditures per capita.

h) Growth in ICT investments by health sector is positively related to growth in per capita health expenditures by total private sector including households, corporations and non-profit organizations.

i) Growth in ICT investments by health sector is positively related to growth in per capita health expenditures by households.

Table 4

Results from Panel Data Regressions, – ICT Investment by Health Sector Sample, 2000-2019

	CHEPC	CHEPC	DGHEPC	DGHEPC	DPHEPC	DPHEPC	OOPEPC	OOPEPC
ELDER	0.29353	0.50838	3.92813	4.03242	**-11.10708****	**-10.60486****	**-10.86366****	**-10.35387***
GDP	**0.867076*****	**0.84339*****	**0.853398*****	**0.841901*****	**0.927148*****	**0.871782*****	**0.934452*****	**0.878251*****
GGFCE	**3.0691*****	**3.080355*****	**3.794985*****	**3.800448*****	0.24685	0.27316	-1.05970	-1.03299
INF	-0.24295	-0.23817	-0.42641	-0.42409	0.40608	0.41725	0.07878	0.09012
LIFE	-1.08638	-0.95738	-0.76279	-0.70017	-1.51854	-1.21698	-0.77894	-0.47284
POP	-1.24597	-1.03220	-1.72631	-1.62254	0.36945	0.86916	0.85268	1.35992
RD	-1.95070	-2.83474	-3.06951	-3.49862	1.54253	-0.52395	3.75674	1.65911
TAX	0.13157	0.11309	0.15825	0.14928	0.11476	0.07157	0.12313	0.07929
ICTBYHEALTH		0.02945		0.01429		**0.068831****		**0.069869****
CONSTANT	**0.029845***	**0.026872***	0.02755	0.02611	0.03540	0.02845	0.03359	0.02654
Adjusted R-squared	0.87683	0.87767	0.84921	0.84817	0.77816	0.78583	0.73792	0.74507
F-Statistics	**30.36565*****	**29.69866*****	**24.23125*****	**23.3446*****	**15.46975*****	**15.67709*****	**12.61455*****	**12.69057*****
Number of Countries/Observations	7/133	7/133	7/133	7/133	7/133	7/133	7/133	7/133

ICT Investment by Health Sector Sample includes data for Australia, Canada, France, Italy, Japan, The United Kingdom, and The United State of America. Since number of cross sections are less than that of coefficients, fixed effects models are used. Empirical results from fixed effects panel regressions are reported. All variables are annual and in the form of periodic percentage change for that variable except INF, whose level form already reflects the periodic percentage change in consumer prices. Here are the descriptions of the underlying variables: CHEPC is per capita current overall health expenditures by government or non-government / private parties and households. DGHEPC is government health expenditures per capita. DPHEPC is per capita health expenditures by private sector including corporations, non-profit agencies and households. OOPEPC per capita out of pocket health expenditures by households. ELDER is total population with age 65 and above; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure (% of GDP); ICTBYHEALTH is health sector investment in information and communication technologies; INF is inflation rate based on consumer prices; LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP; and TAX is Tax revenue as % of GDP. Panel corrected standard error are used in estimations adjusting for heteroscedasticity and correlation. Significant results are in bold. *, ** and *** indicates significance levels at 10%, 5% and 1%, respectively. Source: Authors' computation (2023)

CHAPTER 5

EMPIRICAL RESULTS: IMPACT OF INFLATION AND EXCHANGE RATE ON HEALTHCARE EXPENDITURES

In this section, we examine the impact of inflation and exchange rate on healthcare expenditures in G20 countries during our sample period of 2000-2019. The 19 G20 countries for which we have data are Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Our sample period ends in 2019 because most of the countries did not share data during the Covid19 pandemic period starting 2020.

We use 4 alternative measures of health expenditures, which is the dependent variable in our panel data regressions:

1. Domestic private health expenditure per capita (current US$) denoted as DPHEPC representing the **c**urrent private expenditures on health per capita expressed in current US dollars where domestic private sources include funds from households, corporations and non-profit organizations and such expenditures can be either prepaid to voluntary health insurance or paid directly to healthcare providers.
2. Current health expenditure per capita (current US$) denotes as CHEPC where all current expenditures on healthcare goods and services consumed during each year per capita in current US dollars.

3. Domestic general government health expenditure per capita (current US$) denoted as DGHEPC.
4. Out-of-pocket expenditure per capita (current US$) denoted as OOPEPC representing out of pocket payments are spending on health directly out of pocket by households in each country.

We examine the relationship between each of these alternative health expenditure measure with inflation rate, which is the annual percentage change in consumer prices, denoted as INF and exchange rate, which is the exchange rate between local currency and US Dollars in terms of USD, denominated as EXC. The control variables used are population (denoted as POP), life expectancy (denoted as LIFE), gross domestic product (denoted as GDP) per capita, number of infant deaths (denoted as IMORT), percentage of total population with age 65 or older (denoted as ELDER), tax revenue (denoted as TAX), research and development expenditure (denoted as RD) and total government fiscal expenditure (denoted as GGFCE) as percentages of GDP.

Table 5 presents descriptive statistics for all of the variables. As Table 5 shows mean and median values are close to each other and there are no large standard deviation values for any variables. Table 6 has the cross-correlation results. As Table 6 presents there are no strong correlations among independent variables in our sample of 19 G20 countries during the period of 2000-2019.

Table 5

Descriptive Statistics – G20 Sample, 2000-2019

Variables	Description	Mean	Median	SD	Max.	Min.	Obs.
CHEPC	Current health expenditure per capita (current US$)	6.84296	6.93175	1.54386	9.29844	2.75516	380
DGHEPC	Domestic general government health expenditure per capita (current US$)	6.28091	6.41244	1.81730	8.62202	1.30173	380
DPHEPC	Domestic private health expenditure per capita (current US$)	5.83002	6.05071	1.29302	8.58829	2.32834	380
ELDER	Percentage of total population with age 65 and above (%)	0.11596	0.11180	0.05945	0.28002	0.02937	380
EXC	is the exchange rate between local currency and US Dollars in terms of USD	0.51614	0.26667	0.52334	2.00091	0.00007	380
GDP	GDP per capita (current US$)	9.51425	9.66112	1.18005	11.12956	6.09428	380
GGFCE	General government final consumption expenditure as percentage of GDP (%)	0.16857	0.17722	0.04101	0.30004	0.06532	380
IMORT	Number of infant deaths	9.42695	9.17502	1.90212	14.42465	6.90475	380
INF	Inflation, consumer prices (annual %) based on consumer price index (%)	0.04676	0.02860	0.06457	0.54915	-0.02093	380
LIFE	Life expectancy	4.31954	4.33463	0.09165	4.43505	3.97863	380
OOPEPC	Out-of-pocket expenditure per capita (current US$)	5.34270	5.57394	1.19551	7.11910	1.94323	380
POP	Population	18.43822	18.08971	1.11336	21.06525	16.76797	380
RD	Research and development expenditure as percentage of GDP (%)	0.01480	0.01218	0.00989	0.04627	0.00042	380
TAX	Tax revenue as percentage of GDP (%)	0.20226	0.20622	0.06776	0.30778	0.02332	380

Data other than those denoted as percentages (%) are transformed to logarithm form. G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. SD denotes standard deviation; Max. is maximum; Min. represents minimum; Obs. is number of observations.
Source: Authors' computation (2023)

Table 6

Correlation Matrix– G20 Sample, 2000-2019

Variables	ELDER	EXC	GDP	GGFCE	IMORT	INF	LIFE	POP	RD	TAX
ELDER	1.00000	0.01283	-0.14291	-0.00781	-0.14130	-0.27245	-0.17224	-0.50962	0.09589	0.04167
EXC		1.00000	0.61410	-0.03100	0.05254	-0.39784	0.02833	-0.07959	-0.01363	0.00999
GDP			1.00000	-0.20226	-0.06858	-0.10863	0.07752	-0.02405	-0.02175	0.16819
GGFCE				1.00000	0.00103	-0.02411	0.06008	-0.02071	0.11106	-0.20074
IMORT					1.00000	-0.20538	-0.32486	-0.04380	-0.09068	0.00841
INF						1.00000	0.15616	0.13176	-0.05677	-0.03221
LIFE							1.00000	0.03483	0.00453	-0.04415
POP								1.00000	-0.08531	-0.02753
RD									1.00000	-0.09206
TAX										1.00000

G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Correlation coefficients between independent variables are reported. ELDER is total population with age 65 and above (%); EXC is exchange rate between local currency and US Dollars; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; IMORT is number of infant deaths, INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Data other than those described as percentages (%) are transformed to logarithm form. *Source*: Authors' computation (2023)

Table 7

Results from Panel Data Regressions, – G20 Sample, 2000-2019

	Panel A - Dependent Variable: CHEPC					
ELDER	0.42086	-0.41852	0.85822	0.52250	0.41144	0.42788
EXC	**-0.38214***		**-0.40264***		**0.08387****	**0.07641***
GDP	**0.08060*****	**0.93904*****	**0.07393*****	**0.93995*****	**0.90977*****	**0.90928*****
GGFCE	**0.91017*****	**4.24457*****	**0.90976*****	**4.22957*****	**4.14814*****	**4.14192*****
IMORT	4.16403	-0.14958	4.15928			
INF	-0.12683	-0.00362		-0.00061	0.03216	
LIFE	0.02833	0.32198	-0.13241	0.64435	0.54442	0.57113
POP	0.27497	-0.57127	0.28651	-0.57384	-0.58354	-0.59243
RD	-0.58099	-1.69892	-0.58866	-2.21024	-2.24349	-2.27927
TAX	-1.80864	-0.13368	-1.82085	-0.15613	-0.08744	-0.09799
Constant	0.01104	0.00959	0.01219	0.01231	0.01339	0.01482
Adjusted R-squared	0.88721	0.88634	0.88748	0.88631	0.89236	0.88753
FE or RE	FE	FE	FE	FE	FE	FE
F-Statistics	**62.55912*****	**63.38451*****	**64.09597*****	**64.78477*****	**63.97787*****	**65.56418*****
Number of countries / observations	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361

G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Empirical results from panel regressions are reported. FE or RE denote Fixed Effects or Random Effects. Significant Hausman test statistics at 5% level imply application of fixed effects while insignificant Hausman test statistics at 5% level imply application of random effects. All variables are annual and in the form of periodic percentage change for that variable except INF, whose level form already reflects the periodic percentage change in consumer prices. Here are the descriptions of the underlying variables: CHEPC is per capita current overall health expenditures by government or non-government / private parties and households. DGHEPC is government health expenditures per capita. DPHEPC is per capita health expenditures by private sector including corporations, non-profit agencies, and households. OOPEPC per capita out of pocket health expenditures by households. ELDER is total population with age 65 and above (%); EXC is exchange rate between local currency and US Dollars; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; IMORT is number of infant deaths, INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Panel corrected standard error are used in estimations adjusting for heteroscedasticity and correlation. Significant results are in bold. *, ** and *** indicates significance levels at 10%, 5% and 1%, respectively. *Source*: Authors' computation (2023)

Table 7 -continued

Results from Panel Data Regressions, – G20 Sample, 2000-2019

	Panel B - Dependent Variable: DGHEPC					
ELDER	-1.879597	-1.94836	-1.27519	-0.42281	-0.35263	-0.10325
EXC	**0.005465*** **		0.02853		-0.00008	0.01436
GDP	**0.949912*** **	**0.95163*** **	**0.94636*** **	**0.959102*** **	**0.959567*** **	**0.956529*** **
GGFCE	**5.320274***	**5.357951*** **	**5.364162*** **	**5.384772*** **	**5.349003*** **	**5.383301*** **
IMORT	-0.238124	**-0.238298***	-0.2116			
INF	-0.063402	-0.06589		-0.03698	-0.037	
LIFE	0.297836	0.30355	0.25484	0.90246	0.90399	0.83409
POP	-0.128188	-0.13781	-0.09705	0.0617	0.07031	0.07371
RD	2.814649	2.86331	3.1611	3.66124	3.59342	3.76688
TAX	0.377168	0.36552	0.38608	0.35466	0.36255	0.36704
Constant	0.013959	0.01412	0.01093	0.0145	0.0143	0.01248
Adjusted R-squared	0.78552	0.78964	0.78913	0.79044	0.78626	0.78953
FE or RE	RE	RE	RE	RE	RE	RE
F-Statistics	**291.23880*** **	**320.91640*** **	**323.63320*** **	**360.94710*** **	**323.31030*** **	**364.18010*** **
Number of countries / observations	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361

G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Empirical results from panel regressions are reported. FE or RE denote Fixed Effects or Random Effects. Significant Hausman test statistics at 5% level imply application of fixed effects while insignificant Hausman test statistics at 5% level imply application of random effects. All variables are annual and in the form of periodic percentage change for that variable except INF, whose level form already reflects the periodic percentage change in consumer prices. Here are the descriptions of the underlying variables: CHEPC is per capita current overall health expenditures by government or non-government / private parties and households. DGHEPC is government health expenditures per capita. DPHEPC is per capita health expenditures by private sector including corporations, non-profit agencies, and households. OOPEPC per capita out of pocket health expenditures by households. ELDER is total population with age 65 and above (%); EXC is exchange rate between local currency and US Dollars; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; IMORT is number of infant deaths, INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Panel corrected standard error are used in estimations adjusting for heteroscedasticity and correlation. Significant results are in bold. *, ** and *** indicates significance levels at 10%, 5% and 1%, respectively. *Source*: Authors' computation (2023)

Table 7 -continued

Results from Panel Data Regressions, – G20 Sample, 2000-2019

	Panel C - Dependent Variable: DPHEPC					
ELDER	2.36503	1.172037	2.49621	3.02489	2.60085	2.66909
EXC	**0.25332*** **		**0.25771*** **		**0.25243*** **	**0.25564*** **
GDP	**0.84977*** **	**0.94181*** **	**0.84913*** **	**0.94362*** **	**0.85119*** **	**0.85059*** **
GGFCE	**2.58507*** **	**3.00363*** **	**2.58738*** **	**2.97410*** **	**2.58678*** **	**2.58824*** **
IMORT	-0.03578	-0.29451	-0.03048			
INF	-0.01224	-0.04553		-0.03960	-0.00826	
LIFE	0.06079	0.69933	0.05292	1.33406	0.15004	0.13510
POP	0.51377	0.43894	0.52159	0.43389	0.54424	0.54658
RD	1.82779	1.71968	1.88202	0.71291	1.93750	1.96443
TAX	-0.57891	**-0.94519** **	-0.57568	**-0.98939** **	-0.58055	-0.57809
Constant	-0.00140	-0.01468	-0.00202	-0.00930	-0.00136	-0.00180
Adjusted R-squared	0.81269	0.79938	0.81320	0.79863	0.81317	0.81369
FE or RE	RE	FE	RE	FE	RE	RE
F-Statistics	**157.19430*** **	**32.87580*** **	**175.13370*** **	**184.01680*** **	**175.10290*** **	**197.53810*** **
Number of countries / observations	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361

G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Empirical results from panel regressions are reported. FE or RE denote Fixed Effects or Random Effects. Significant Hausman test statistics at 5% level imply application of fixed effects while insignificant Hausman test statistics at 5% level imply application of random effects. All variables are annual and in the form of periodic percentage change for that variable except INF, whose level form already reflects the periodic percentage change in consumer prices. Here are the descriptions of the underlying variables: CHEPC is per capita current overall health expenditures by government or non-government / private parties and households. DGHEPC is government health expenditures per capita. DPHEPC is per capita health expenditures by private sector including corporations, non-profit agencies and households. OOPEPC per capita out of pocket health expenditures by households. ELDER is total population with age 65 and above (%); EXC is exchange rate between local currency and US Dollars; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; IMORT is number of infant deaths, INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Panel corrected standard error are used in estimations adjusting for heteroscedasticity and correlation. Significant results are in bold. *, ** and *** indicates significance levels at 10%, 5% and 1%, respectively. *Source*: Authors' computation (2023)

Table 7 -continued

Results from Panel Data Regressions, – G20 Sample, 2000-2019

	Panel D - Dependent Variable: OOPEPC					
ELDER	-1.78242	-1.89879	-1.76539	0.53875	0.18656	0.17939
EXC	**0.25786*** **		**0.26340*** **		**0.26596*** **	**0.26922*** **
GDP	**0.83565*** **	**0.92800*** **	**0.83599*** **	**0.93037*** **	**0.83466*** **	**0.83487*** **
GGFCE	**2.43809*** **	**2.69575*** **	**2.44204*** **	**2.65691*** **	**2.39868*** **	**2.40139*** **
IMORT	-0.31468	**-0.38745***	-0.31004			
INF	-0.02355	**-0.12577***		**-0.11797***	-0.01404	
LIFE	-0.28989	-0.13952	-0.29948	0.69551	0.37864	0.36698
POP	-0.34163	-0.31054	-0.33526	-0.31719	-0.34797	-0.34410
RD	-2.01379	-1.66280	-2.00365	-2.98728	-3.09272	-3.07711
TAX	**-0.81988***	**-1.02014****	**-0.81280***	**-1.07828****	**-0.86046***	**-0.85586***
Constant	0.00367	-0.00098	0.00271	0.00609	0.00951	0.00889
Adjusted R-squared	0.76043	0.75036	0.76114	0.74891	0.75972	0.76046
FE or RE	FE	FE	FE	FE	FE	FE
F-Statistics	**25.84095*** **	**25.04605*** **	**26.49179*** **	**25.40315*** **	**26.29408*** **	**26.97432*** **
Number of countries / observations	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361	19 / 361

G20 Sample includes data for Turkey, Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, The Russian Federation, The Kingdom of Saudi Arabia, The Republic of South Africa, The United Kingdom, The United State of America. Empirical results from panel regressions are reported. FE or RE denote Fixed Effects or Random Effects. Significant Hausman test statistics at 5% level imply application of fixed effects while insignificant Hausman test statistics at 5% level imply application of random effects. All variables are annual and in the form of periodic percentage change for that variable except INF, whose level form already reflects the periodic percentage change in consumer prices. Here are the descriptions of the underlying variables: CHEPC is per capita current overall health expenditures by government or non-government / private parties and households. DGHEPC is government health expenditures per capita. DPHEPC is per capita health expenditures by private sector including corporations, non-profit agencies and households. OOPEPC per capita out of pocket health expenditures by households. ELDER is total population with age 65 and above (%); EXC is exchange rate between local currency and US Dollars; GDP is Gross domestic product per capita; GGFCE is General government final consumption expenditure as % of GDP (%); ICTBYHEALTH is health sector investment in information and communication technologies; IMORT is number of infant deaths, INF is inflation rate based on consumer prices (%); LIFE is Life expectancy; POP is Population; RD is Research and development expenditure as % of GDP (%); and TAX is Tax revenue as % of GDP (%). Panel corrected standard error are used in estimations adjusting for heteroscedasticity and correlation. Significant results are in bold. *, ** and *** indicates significance levels at 10%, 5% and 1%, respectively. *Source*: Authors' computation (2023)

This section presents the empirical results from panel data regressions to examine the role of exchange rate and inflation changes on health expenditures in G20 countries. We decide on whether to use fixed effects or random effects model for panel data regressions based on the Hausman test (Green, 2003): In case the estimated Hausman test statistics is significant with a p-value less than 0.05, indicating the rejection of the Hausman test null hypothesis, fixed effects model is used, otherwise, random effects model is applied. The results from the panel regressions are reported in Tables 7. We estimate four main sets of equations for each health expenditure measure (Domestic private health expenditure per capita, Domestic general government health expenditure per capita, Current health expenditure per capita, and Out-of-pocket expenditure per capita), each with six different specifications. This is done to avoid spurious estimates. As a result, a total of 24 columns in each table show the 24 main specifications. We report each alternative health expenditure measure, our dependent variables, in a separate panel in Table 7: Panel A is for the dependent variable CHEPC based on the current health expenditure per capita, Panel B is DGHEPC based on the domestic general government health expenditure per capita, Panel C is DPHEPC based on the domestic private health expenditure per capita including expenditures by corporations, non-profit organizations and households, and Panel D is OOPEPC based on the out of pocket household health expenditures per capita.

The results of the parameter estimate from the panel data regressions for the G20 countries during the period of 2000-2019 can be summarized as follows:

a) The growth in GDP per capita, the growth in the weight of government expenditures in GDP are primary factor influencing health expenditures by government or private sector or households as coefficients for these factors are significantly positive across all regressions for all types of health expenditures.

b) Changes in exchange rate is significantly and positively related to the growth rates in health expenditures by private sector as well as by households.

c) Growth in tax revenue as a percentage of GDP is significantly negatively related to the growth in especially household out of pocket health spending as well as the private sector health expenditures.

CHAPTER 6

CONCLUSIONS AND DISCUSSIONS

In conclusion, this study focused on the relationship between health expenditures and two important financial indicators, exchange rate and inflation rate, in G20 countries (excluding EU countries) using data from the World Bank's World Development Indicators database for the period 2000-2019. Four proxies were used to measure healthcare spending, namely current health expenditure per capita, domestic general government health expenditure per capita, domestic private health expenditure per capita, and out-of-pocket expenditure per capita. Additionally, several other economic variables were included in the analysis, such as GDP per capita, general government final consumption expenditure as a percentage of GDP, infant mortality rate, life expectancy, population, research, and development expenditure as a percentage of GDP, and tax revenue as a percentage of GDP.

The findings of the study suggest that exchange rate and inflation rate are significant determinants of health expenditures in G20 countries (excluding EU countries). Changes in exchange rate were found to play an important role in changes in health expenditure, while changes in inflation rate were inversely significant in all health expenditure models (except for domestic general government health expenditure per capita) on average, even without exchange rate data in the model. GDP per capita and general government final consumption expenditure as a percentage of GDP were identified as important determinants of health services. Tax revenue as a percentage of GDP was found to be a significant inverse determinant of domestic private health expenditure per capita and out-of-pocket expenditure per capita.

Furthermore, the study also examined the relationship between health expenditures and ICT (Information and Communication Technology) investments in the health sector in seven countries among the G20 countries, namely Australia, Canada, France, Italy, Japan, the United Kingdom, and the United States of America. Data availability limited the scope of the study to the period from 2000 to 2019, and only these seven countries had data on ICT investments in the health sector. The study used the same proxies for measuring healthcare spending as in the previous analysis. The relationship between ICT investment in the health sector and health expenditures was examined using panel data analysis and found that ICT investment by health sector is significantly positively related to non-government health spending by households, corporations and non-profit organizations while there is no significant relation between government health expenditures and heath sector ICT investments.

In general, findings of this study provide evidence-based information for understanding the differences in the health system and explaining determinants that impact the dynamics of health expenditures. The results highlight the importance of exchange rate and inflation rate as significant determinants of health expenditures, and emphasize the role of GDP per capita, general government final consumption expenditure as a percentage of GDP, and tax revenue as a percentage of GDP in influencing health services. Additionally, the study suggests that ICT investments in the health sector may have an impact on health expenditures in the countries analyzed.

It is important to note that this study has some limitations. Data availability and quality may vary across countries and over time, which could affect the accuracy and reliability of the findings. The use of proxies for measuring healthcare spending may not capture all nuances of health expenditure patterns in different countries. The study also focuses on G20 countries (excluding EU countries) and may not be generalizable to other

countries or regions. Additionally, the study does not establish causality between the variables examined, and further research may be needed to better understand the underlying mechanisms driving the observed relationships.

Overall, this study contributes to the literature by examining the relationship between health expenditures, exchange rate, inflation rate, and ICT investments in the health sector in G20 countries. The findings provide insights into the determinants of health expenditures and may inform policy decisions related to healthcare financing and resource allocation in these countries. Further research in this area is warranted to expand the understanding of the complex relationships between health expenditures, financial indicators, and other economic variables, and to validate the findings in different settings.

Finally, it is crucial that every individual has uninterrupted access to health services. Fluctuations and changes in health expenditures can make access to health services difficult. This study will help us understand the financial variables in health expenditures, and the data and results obtained in this direction will help policymakers to take action.

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