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What Has Digitalisation Done for the Economy? Examining the effect of eGovernment and Public Digitalisation on Economic Growth

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Declaration of Originality

I hereby declare that this bachelor thesis is my work and has not been published in whole or in part elsewhere. All literature sources used in this thesis are attributed and cited in references.

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Abstract

This paper will add to the growing body of research concerning the interaction between digitalisation of the public sector, namely, the government, and economic prosperity, that being growth in GDP, HDI, and decreasing unemployment. The novelty of this paper will be in its application of the Institutional approach to digitisation. The author approaches the issue from the perspective of the New Institutional School of Economics as pioneered by Acemoglu et al. (2011) in How Nations Fail, keeping extractive and inclusive political and economic institutions in mind. The institutional school holds that under non-inclusive economic conditions, growth becomes stunted, ergo, in a modern digital economy, a government that is lacking in its eGovernment should not be able to fully provide suitable conditions for economic growth. This paper analyses this hypothesis and finds no causality between an improved eGovernment and HDI or GDP but a strong relationship between improved eGovernment and lower unemployment rates.

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Abstrakt

Tento dokument prispeje k rastúcemu počtu výskumov týkajúcich sa interakcie medzi digitalizáciou verejného sektora, menovite vládou a ekonomickou prosperitou, teda rastom HDP, HDI a znižovaním nezamestnanosti. Novinkou tohto príspevku je aplikácia inštitucionálneho prístupu k digitalizácii. Autor pristupuje k problematike z pohľadu Novej inštitucionálnej školy ekonómie, ktorej priekopníkom je Acemoglu et al. (2011) v knihe How Nations Fail (Ako národy zlyhávajú), pričom majú na pamäti extrakčné a inkluzívne politické a ekonomické inštitúcie. Inštitucionálna škola zastáva názor, že v neinkluzívnych ekonomických podmienkach rast zaostáva, ergo, v modernej digitálnej ekonomike by vláda, ktorej eGovernment chýba, nemala byť schopná v plnej miere zabezpečiť vhodné podmienky pre ekonomický rast. Táto práca analyzuje túto hypotézu a nenachádza žiadnu kauzalitu medzi zlepšenou elektronickou správou a HDI alebo HDP a silný vzťah medzi zlepšenou elektronickou správou a nižšou mierou nezamestnanosti.

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Introduction

What happens when an economy is, at least in terms of its technological development, light-years ahead of its government? Does it continue, unbridled by pesky bureaucrats, running of into the proverbial sunset of economic prosperity? Or, conversely, does the fact that government employees can't even open an email make them all the more of a massive speed-bump (if not a brick wall) when it comes to economic development. What exactly is the relationship between the quality of eGovernment and economic (GDP, HDI, and unemployment) development?

Goldfinger (1999) has found that the world is shifting more and more from the tangible, towards the intangible alluding to the case and point of his study, the ramifications of productivity shifting away from industry and towards technology for statisticians and economists. Long gone are the days of industry, where being able to produce more coal, more cars, or more toasters than your neighbour would make you the most powerful economy on the bloc. More and more, the ability to shift towards the digital, and the ability to interact with the digital world meaningfully is becoming the key driver behind economic growth.

Given that the phenomenon of digitalisation is fairly new, there are still many questions and phenomena that need to be explored, with each question in this field gaining more and more relevance as governments vie to digitalise their structure and with that their economies as a whole. For this reason, it is particularly interesting to look at whether different relationships between government and digitalisation can foster different growth rates, in order to guide better policy making which is nearly certain to happen in the future, or, to at least prevent disastrous decisions. This research is relevant to policymakers, policy researchers and government technocrats.

The key concepts within this paper are digitalisation, *i.e* the transformation of information and services into such a form that they are accessible by information and communications technology, economic growth and performance, which usually involves the development of key macroeconomic indicators such as GDP (Gross Domestic Product), unemployment or HDI (Human Development Index). Another key concept will be the relationship between unemployment and eGovernment. The last,

and probably most important concept is digital government or eGovernment, the transformation of government services and functions away from pen, paper and typewriter into a form more accessible to computers.

The field of research for this thesis is economics and digitalisation, looking at the relationship between the public sector and economic growth. This paper is looking at the relationship between eGovernment and economic growth, so the broad field for this paper is development. Because this paper is a comparative study, it could also be said to belong in the comparative field within the social sciences.This paper approaches from the point of view of the Institutional School of Economics, or, more broadly, the School of New Institutionalism. Institutionalists posit that formal and informal institutions (in this case, the Government) set the conditions which can either promote or discourage economic growth, and ergo they are, to a certain extent, arbiters of an economy's fate. This paper also looks at various forms digitalisation within an economy can take place, from public, which can expand government services, private; which involves increasing productivity, and monetary, by which transactions become easier to facility through the use of ICT technologies.

The Institutional approach to economics has seen a resurgence in recent years, with the renaissance of the Institutional School of Economics in New Institutionalism. Particularly essential to this paper is the notion of how institutions are essential for the functioning of politics and economics, and how they need to be inclusive in order to maintain cohesive, longterm growth. The author takes this concepts and applies it to digitalisation, where the idea is that governments with poor eGovernment infrastructure inherently cannot be inclusive, as they lack the interface for coexisting with a modern digital economy.

Furthermore, to account for leftover extractive institutions from socialism, this paper will compare four countries which could be divided into two groups: two post-socialist, two which were on the other side of the iron curtain, and two which are *ex ante* deemed to be performing well in terms of digitalisation and two which aren't. The countries are Greece (poor digital performance, no former communist regime), Slovakia (poor digital performance with former communist regime), Finland

(excellent digital performance, no former communist regime) and Estonia (excellent digital performance, with former communist regime)

In terms of methodology, this paper looks at how changes in a digitisation indicator translates into GDP/HDI growth rates or a lower unemployment through a comparative lens.The purpose of this paper is to delineate the relationship between the quality of eGovernment and economic prosperity in this sense. It is inevitable, given the global nature of corporations in the 21st century, that the private sector in most countries will digitalise, following trends from more advanced economies. What is far less certain, is whether or not a government that can't keep up with this digitalisation will be a detriment to economic prosperity. And, further to the point, is the successful digitalisation of the government and its institutions a driving force behind economic growth?

The research question of this paper is: "Is there a positive relationship between improvement in eGovernment and economic growth (greater GDP, HDI, and lower unemployment)?" and the hypothesis of this paper is: "Yes, a lacklustre eGovernment is a detriment to economic growth (slower improvement in GDP) as it is incapable of creating inclusive economic institutions that are the driver of growth."

1. Literature Review and Theoretical Framework

The theoretical framework and literature review of this paper aim to look at what has already been written on the field of digitalisation, and its relation to public and private economic developments. Some expected findings of this section the definition of digitalisation, the relationship of digitalisation with governments, along with its relationship with growth, productivity, and money. It will also cover the nature of institutions and how their interaction with individuals impact growth.

1.1 What is Digitalisation

Over the past years, the onset of new technologies has sparked a popular, academic, political and economic interest in new technologies around the world, and the process of digitisation. This section seeks to define digitalisation while also providing a brief overview and history of the term.

The word digitalisation has its root in the word digital. The Online Etymology Dictionary defines the word “digitalise” as “convert into a sequence of digits” (Online Etymology Dictionary). The word digitalise itself comes from a merging of the word “digital” and the suffix “-ise”. The entry in the Online Etymology Dictionary goes further to define the definition of digital:

> mid-15c., "pertaining to numbers below ten;" 1650s, "pertaining to fingers," from Latin digitalis, from digitus "finger or toe" … The numerical sense is because numerals under 10 were counted on fingers. Meaning "using numerical digits" is from 1938, especially of computers which run on data in the form of digits (opposed to analogue) after c. 1945. In reference to recording or broadcasting, from 1960.

The Oxford Learner’s Dictionaries defines digitalisation as “the process of changing data into a digital form that can be easily read and processed by a computer” (Oxford Learner's Dictionaries). The verb digitise is defined as “to put information into the form of a series of the numbers 0 and 1, usually so that it can be understood and used by a computer” by the Cambridge Dictionary (Cambridge Dictionary, 2019).

Despite its only recent introduction to popular discussion, we can see that the word digitalisation has been in use for about three quarters of a century, emerging around the late turn of the 20th century. At its inception, digitalisation had been used to describe the process by which companies and governments turn information that had been stored at physical archives in vaults or libraries into a medium that can be processed and displayed by digital devices utilising the silicon chip. By this metric, most businesses and governments around the world are digital, and indeed, most governments around the world do make the claim that they are digital.

Broadly, digitalisation can be defined as a process by which information and some assets are transformed in such a way as they are readily accessible by Information and Communications Technology (ICT) . This can be seen in processes such as the aggregation of statistical data, but also through the ability of customers requesting services, public and private, through the means of the internet. In recent decades, the ability to pay with these services has also become a part of digitalisation. The purpose of the following chapters shall be the discussion of digitalisation with greater detail in relation to these various services and methods of payment along with their relation to employment and labour markets.

1.2 Public Sector Digitalisation

A new global obsession with digitalisation has created inflation of policies and definitions, each contending over what digitalisation is, what its purpose should be and how it should be implemented within the public sector. In the Anglo-Saxon world, digitalisation (namely of the government) has been seen as a measure by which governments can expand the efficacy of their services while also cutting their costs. On the other hand, in Europe digitalisation has become a phenomenon that is seen by more and more as a source of growth and economic stimulus that can bring prosperity to all. What does public digitalisation look like?

Silverman (2017) notes that there has been great discussion of digitalisation in the recent years, with some commentators of going so far as to proclaim it a shift from the old paradigms of e-government to digital government. His book is a synthesis of

several authors who have written on the subject, and thus provides an a general overview and several viewpoints on the subject. Silverman explains that e-government is something that first came to be at the beginning of the new millennium over two decades ago. He outlines that this initial change was rather a focus on the implementation of online services rather than a thorough digital restructuring of the government, and therefore the more recent implementations of digitalisation are sharply distinct from now archaic attempts to implement email communications between citizens and bureaucrats.

Silverman describes several strategies that now exist throughout the world in regards to digitalisation: Citizen Service and Innovation in the US, Cost Savings in the United Kingdom, and Jobs and Growth in the European Union. Citizen Service and Innovation is a policy brought on by two advisory groups within the White House and is aimed at implementing mobile compatibility for at least two government services for customers. Cost Saving in the UK is a strategy that has been picked up by the UK, which calculated that it would be able to save at least £1.8 milliard by switching to a "digital by default" strategy. Silverman writes:

> For some government services, the average cost of a digital transaction is almost 20 times lower than the cost of a telephone transaction, about 30 times lower than the cost of postal transactions and about 50 times lower than a face-to-face transaction (p.7)

For the EU, Silverman writes that policymakers expect digitalisation to be a boon to the GDP, boosting it by an overall 5 per cent, or €1,500 per capita. The Unions plan is to invest heavily into ICT but also into reselling, with a long-term goal of creating as many as 3.8 million new jobs through the investment programme. As we can see, there is no shortage of philosophies when it comes to public sector digitalisation.

A multiplicity of goals and ambitions seems to be present in other countries as well. Silverman writes on this theme:

> Having multiple plans owned by different departments is the rule in digital government today. When it comes to implementation, different departments are getting involved, resulting in overlap and increasing coordination efforts, often with- out an oversight institution being in place. As we show in this book, taking implementation down to the program and/or institution level is even more disconnected.

> The "return to digital" is assessed today only in a patchy manner. The National Audit Commission in Australia or the US Office of Budget and Management, for example, are assessing how the government is doing against plan, but are not talking about social or economic outcomes. The UK looks through the lens of cost reductions and efficiency increases, assuming savings of 200 million pounds related to digital. Germany has yet to evaluate the return on digital.(p.6)

The ambition for digitalisation in many countries has had a broad announced scope, but its implementation seems to be chaotically and uncoordinated between various agencies, institutions and government ministries. This issue of governance is being tackled cross institutionally, with governments erecting additional institutions for the purpose of maintaining cohesiveness of policy across institutions.

Other problems digitalisation would face according to Silverman are those of change management, security, and labour markets. Change management involves gearing up for a change caused by large-scale government digitalisation, or as Silverman puts it "A true digital transformation requires a radically different way of doing things, including a different culture, role definition and collaboration in government. This is a journey which began in the age of eGovernment but is set to continue in a more complex and demanding environment" (p.9). The other issue is that of security. Silverman points out that, for example, the United Kingdom loses £21 milliard to fraud, and consequently, governments need to invest more in order to prevent the abuse of digital services. This leaves the problem of labour markets.

In regards to labour markets, there are several theories about what the effect of digitalisation may be. Silverman presents three leading hypotheses as to what the result of the digitalisation will be, those being chiefly the substitution theory, the zero sum game theory and the business as usual theory. The zero sum game theory postulates that practically no job is immune to digitalisation with the governments role in the future being that of guaranteeing welfare for the vast majority of the population. The substitution theory postulates that some jobs will get replaced, and that there will be a need for retraining. The business as usual theory posits the theory that though a lot of jobs may be taken over by robots, new jobs will emerge and prevent mass unemployment.

The United Nations defines eGovernment as:

> E-government can thus be defined as the use of ICTs to more effectively and efficiently deliver government services to citizens and businesses. It is the application of ICT in government operations, achieving public ends by digital means. (United Nations, n.d.)

or in other words the integration of various new technologies in society to government services to provide a network effect of various services through the means of these technologies. This definition is very broad, and encapsulates everything from using new ICT for communication between government employees to streamlining web services for clients so that they do not have to waste time at a government office, and rather, can access the same services from the comfort of their home by using their phone or computer. A similar point was made by Fang (2002) , who emphasised that

> One of the most important aspects of e-government is how it brings citizens and businesses closer to their governments.(Fang, 2002)

Thus, it can generally be stated that besides all the other afore mentioned factors, it is the role of the eGovernment to facilitate a network effect between various parties such as firms, citizens and the government.

1.3 Defining Digitalisation's Relation to Employment and Productivity

First and foremost it is important to define digitalisation and how it plays into the current framework of working economic theories. The onset of Industry 4.0 has without a doubt revolutionised many aspects of day to day lives, but also improved the efficiency of workplaces, expanded the accessibility of financial institutions and financial operations, and exponentially increased the obtainability of information which allows for procedures like data analysis. The onset of these new technologies and their incorporation into the broader economy as a new productive paradigm has been dubbed as the "digital economy" (Kehal and Singh, 2005). They further write:

> A digital economy is a convergence of communications, computing, and information. The new economy is basically about coordination, innovation, selection and learning […] The combination of networked computing technologies and new business models is creating entirely new markets, industries, businesses, and work

> practices today to form a digital economy. The new economy or digital economy is based more in the form of intangibles, information, innovation, and creativity, in expanding economic potential […] and is based on the exploitation of ideas rather than material things. (p.3)

This new digital economy has several perks which distinguish it from previous economic paradigms, which can be summarised into 3 broad categories (Goldfinger, 1997).

The first is a change in the structure of the labour market. In his 1997 study, Goldfinger finds that even in their infancy digital economies saw a shift away from agricultural and industrial production towards services. He found that at the end of the 20th century, agriculture and industry had moved down from being an overwhelming majority employer to employing below 40% of the working population in the member states of the EU. Furthermore, he wrote: "Services represent the lion's share of both employment and output and constitute the principal, and for some countries the only, source of employment growth."

Further, this new economic model has been more broadly associated to be a part of the greater globalisation of the world that has been underway since the second half of the 20th century. This globalisation meant two things - increasing cross-border trade of goods and services alongside an expanding deployment of "production facilities, distribution networks, technologies and people," (Goldfinger, 1997). Access to the internet, in particular, allows for greater access to information and a greater customer base to pull from for firms (Kehal and Singh, 2005), effectively creating a synergy between liberalised trade agreements and the shrinking of the world through the onset of the internet and services like e-commerce.

The final aspect of this new economic paradigm is the omnipresence of Information Technology (IT) (Goldfinger, 1997). In his 1997 paper, Goldfinger already outlines the impossibility of overstating the effect digitalisation has had on the economy, but since then, the integration of day to day life with information technologies has increased and has become far more streamlined and ubiquitous than some 20 years ago. For example, the share of households in the US that had at least one personal computer when Goldfinger's paper was published (1997) was 36.6%

(Alsop, 2020), and increased to 89.3% in 2016. It would in shape or form be hyperbole to say that the digital economy runs on computers.

Goldfinger (1997) also refers to several controversies in then-contemporary economic discourse; particularly relating to the Solow paradox; that being the seemingly contradictory nature between the growing investment into and scaling complexity and capability of Information Technologies throughout the 1970s and the 1980s which was seemingly met with a slump in productivity. Goldfinger provides an overview of different sides of the debate over the Solow paradox, presenting both information that contradicts, but also expert opinion claiming that the paradox will persist in the realm of reality so long as new digital resources are used inefficiently. These claims about productivity slumps despite large investment in technology caused by inefficient resource allocation were largely picked up on by the New Institutional school of economics. These institutional studies theorised that if initial development lacklustre future development could continue down the same path. This is because according to the Institutional School new development often relies on previous findings and more often than not trudges in the same direction. This type of development was named “path dependence” (Matraeva et al., 2020). Particularly, it was shown that previous development could affect the course of future technological and socio-economical development. Furthermore, it was demonstrated that when actors are choosing a development path to go by they may erroneously choose a path that may in the short run be beneficial but in the long run, a net negative, creating detrimental path dependence or an “institutional trap” (Lesnyh & Ilyashenko, as cited by Matraeva et al., 2020).

To conclude this section: development in new information technologies has led to several major economic changes on global and national levels. Firms started to leverage greater information and computing power that came from new developments. These developments often synergised with increasingly liberalised trading relations throughout the world, allowing for companies to distribute their supply chains and production all around the world and reach growing populations of customers around the world. At the same time, it also became possible for firms and nations to fall into institutional traps like those of the Solow paradox, where

increasing investment in information technology failed to reach a satisfactory outcome due to incorrect or poor resource assignment.

1.4 Institutional Economic Theory and New Institutionalism

Belonging to the New Institutional movement within the social sciences, the New Institutional School of economics posits that as equal, if not more important than the rational choice of *Homo Œconomicus* that Classical Economists claim is the most important aspect of economics, are institutions. Niall Ferguson (2013) compared humans to a bee hive when talking about institutions, claiming that institutions are much like the bee-combs in a bee-hive, that give shape and structure to human political and economic activities. His point was that institutions, in particular, good institutions can be the drivers of economic well-being and technological innovation.

In their book *Why Nations Fail,* economists Acemoglu and Robinson (2013) make a similar case, arguing that the drivers of economic prosperity and success are inclusive (as opposed to extractive) political and economic institutions. These institutions are the source of long term economic growth and prosperity arguing that without them sustainable growth becomes impossible. For this, they give the example of the Congo and its long struggle with finding stability and growth. They make the case that institutions built in the Congolese monarchy, both political and economic, were extractive and designed to facilitate the extraction of slave labour and maximise slave trade for the king of Kongo. These institutions persisted into the Congolese colonial and modern dictatorial states.

The authors argue that the institutions were never reformed because in order for institutions to transform from extractive into inclusive institutions, elites would have to make considerable economic and political wellbeing that would at least damage their privileged status in society and at worst leave them at the mercy of the people they oppressed. Acemoglu et al. call the winners of these changes *economic and political winners* whereas *economic and political losers* are those who largely loose from the restructuring of society. Similarly, there was no bottom-up drive in the Congo for economic improvement, as the extractive institutions that existed within the

kingdom, and later in the colony and independent state, discouraged individuals to implement new and better technologies and methods.

Therefore, institutions don't change and block economic change and modernisation, as those in power fear becoming economic and political losers of the new change that may take place within the country. Similarly, those who are the current economic and political losers of extractive institutions have little incentive to push for innovation on their end, as any improvements that they may accomplish won't benefit them but rather the elites who benefit from the extractive institutions.

From the point of view of digitalisation, this framework may explain several hypothetical courses of action by various actors. Governments may oppose digitalisation because it may create economic losers out of the current group of elites, or in some form disadvantage them. Similarly, there may be no drive for digitalisation from bottom up if government institutions are extractive and kill any motive individuals or businesses may have to drive the process.

1.5 Hypothesis

Digitalisation is a process which can be largely beneficial to the economy. It can benefit firms, individuals, financial institutions and policy makers. However, this does not mean that digitalisation is risk free - countries undergoing the process of digitalisation risk falling into an institutional trap leading to lower productivity, or digitalising their money in such a way that it ostracises groups that rely on cash or hinders the function of its financial institutions, or both. Other problems could include poor incorporation of technologies by governments or a failure to invest in education for the purpose of preventing a skill miss-match, and thus creating deadweight.

Due to the onset of new technologies that have made digitalisation inevitable, a successful digital economy is a dynamic development factor for nations all around the world. However, problems can arise if a government is not sufficiently digitalised; being unable to interface with a digital economy, it will become incapable of creating inclusive economic institutions for the purpose of growth.

2. Methodology

To test the hypothesis of this posited in the earlier chapter, this paper will take the form of a quantitative and comparative study, taking information from an existing digitalisation index and creating an overall model for the purpose of observing trends which may correlate or contrast with the hypothesis. These trends will be observed through an econometric OLS (Ordinary Least Squares) regression, a procedure that will allow us to determine if there is causality between government digitalisation and our chosen variables in the countries that we will be observing. The aim of the quantitative comparison is examine if there is a cause and effect relationship between government digitalisation and economic growth, and specifically, to see how each percentage change in digitalisation translates into economic growth.

For this purpose, the paper will examine separate countries and their scores regarding digitalisation. Since the purpose of the paper is determine a correlation, an approach that favours comparisons of various countries has been selected. This study will look at the countries of Slovakia, Estonia, the Finland and Greece in a comparative study. Slovakia and Estonia are worthy candidates for comparison because they are both relatively small, post communist countries, in the EU and have both formerly been parts of larger political constructs (Czechoslovakia and the USSR respectively). On the other end, Finland and Greece serve as controls for Estonia and Slovakia - they are also both relatively small countries, however, their development was not hindered by communism and therefore may alert us to the nature of certain trends if they are present only Slovakia and Estonia or Finland and Greece.

The choice of these countries has another reason - they are all EU member states, and thus finding methodologically consistent data on them is easier. Their choice has also been made based on their *ex ante* research digitalisation perception. According to the Google Digital Readiness Index (Beblavý et al., 2019), Estonia is the best ex-communist, and indeed the best digital country in the EU. On the flip side, Slovakia is one of the worst and has a population comparable to Estonia. Of the noncommunist states, Finland has the best score of countries with a comparable population, whereas Greece has the worst score of those with a comparable population

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2.1 Calculating Economic Growth

The study will take a comparative approach to these four countries, comparing digitalisation scores and economic growth from 2003/04 to 2019 to determine wether or not a failure to develop digital and e-government tracks with impeded economic growth. The digitalisation index will be tracked with established economic growth indicators, namely GDP/HDI growth and lower unemployment rates. The study will favour sources that contain information for all 4 chosen states to ensure uniformity and minimise statistical noise.

There are two main methods of measuring economic growth, GDP and HDI. This study will also look at unemployment rates alongside these indicators. GDP, or gross domestic product is totality of what is produced within an economy over the course of a year (Samuelson & Nordhaus, 2010). Because GDP is also affected by prices, and prices are affected by inflation, this study will calculate with *real* (i.e measuring the prices of goods and services produced over the years in the the prices of one year, or according to an index) rather than *nominal* (measuring the GDP in the prices of that year) GDP, a price index has been chosen for this paper to ensure the calculation is accurate notwithstanding inflation.

Economic growth, in terms of GDP, can come as a result of a change in any of the key factors that make up the GDP. If we say that y is the GDP, or economic output of an economy, then the key makeup of a GDP is:

$$y = C + I + G + (X-M)$$

Where C is consumption, I is investment, G is government spending and $(X-M)$ is net exports (exports - imports). To be able to further control our variables, we can outline what affects these factors of the GDP. C is affected by real wages, tax cuts and lower interest rates. Increase in government spending affects G, devaluation of currency causes exports to increase and imports to decrease in I. Lower interest rates also cause an increase in I.

Based on our knowledge of what causes changes in GDP, we can design our controlled variables. Effectively, the GDP can be effected by the level of taxation, as it influences government expenditure, consumption and investment. Higher interest rates mean that money is more expensive, thus interest rates can have direct effect on consumption, investments, government spending and import/export as the availability of money has an effect on all of these. Consumer prices effect exports, imports and consumer spending, making that another controlled variable. Lastly, employment levels in an economy determine the extent to which that economy is productive, ergo making it another viable controlled variable. Lastly, there may be other unknown, unaccounted factors, or noise which can distort our results; to capture these factors, we could use a lagged substitutive variable, *i.e* GDP from previous years. Since the component of the GDP are consumption, investments, government spending and net exports, a lagged GDP would show us how past conditions of the GDP have led to the current state of the GDP.

Tax rates effect the GDP through two different means. One would be through the creation of deadweights, while the other would be through a lack of funding. A deadweight, in simple terms, is a disequilibrium created by taxes raising costs, and hence preventing the market from reaching equilibrium. For example, a VAT may effect the viability of a business as it could raise prices to such a level that consumers may no longer be able to buy a certain good, and the store owner may not be able to reduce the price as it could prevent him from gaining money. Conversely, income taxes can prevent consumers from buying as much as they want, as a part of their salary goes towards paying taxes rather than being allocated towards what they would rather buy. As Mankiw (2018) put it "Taxes cause deadweight losses because they prevent buyers and sellers from realising some of the gains from trade." The second ay in which taxes can effect the GDP is, that if they are too low, the GDP of a country can also suffer. Taxes are one of the main ways by which governments can fund themselves, and governments play an important role in the economy by providing essential goods and services, namely public goods, which usually aren't provided by the free market. A fall in taxation can thus result in a lower GDP In this study taxes will be measured by what percentage of GDP comprises of income taxes.

Monetary and fiscal policy can have a huge effect on the economy of a country. The main results of such policies are changes in interest rates and inflation. For these reasons, these factors will be controlled for in this study. Inflation, or in other words, the augmentation price levels, which is measured in the consumer price index, or for the European Union, the Harmonised Index of Consumer Prices (HICP), can also have a notable effect on the GDP. High inflation usually means that money is cheap and easy to come by. This can, on the short run, increase demand for goods and services which is why central banks lower interest rates during recessions, as there is a short run relationship where increased inflation causes lower unemployment. Interest rates can contribute to economic growth through their effect on the money supply; so while during a depression a central bank may decrease rates to stimulate the economy, a central bank may increase rates to prevent inflation from becoming hyperinflation. The interplay between these two phenomena and the effect of the money supply on aggregate demand and supply in the economy as a whole play a large role in the development of the GDP. Therefore, these two variables will be included in our regression.

There are however, other things that can affect the economy, namely those of health and education. These can be measured through a substitutive variable: the Human Development Index. The Human development index captures life expectancy, years spent in education and income. Thus, the HDI, through its description of life quality can act as a substitutive variable for the quality of human capital/education, a factor that can notably impact productivity. Ergo, this shall work as another controlled variable.

To further break down the components of the HDI: Years spent in education can tell us a lot about the quality of human capital in a country. Naturally, the more years people spend in a country in education, the more qualified and skilled they will be and hence more capable of carrying out complex tasks in their workplace, hence bringing greater value to their employer and to the customer buying their product. Life expectancy can also tell us a lot about a country's economic situation, as in a country where people live longer, members of society can remain productive for a longer

period of time, especially in leadership role where they may use their accumulated experience. Income, or GNI per capita is a variable that tracks very closely to the GDP, with some deviations. Having a good income is naturally going to improve the economic standing of a country, as people have access to a greater amount of goods and services.

Unemployment levels have an interesting effect on economic growth, and tells us a lot about the state of an economy. The unemployed represent a segment of the population that is a part of the labour force, wants to be employed, but cannot find work. There can be several types of unemployed, some of which are seen as generally not very damaging (e.g frictional unemployment, something that almost everyone experiences in the short period between leaving an old job and looking for a new one) to more serious ones, such as structural unemployment, which is a result of a severe skills mismatch. This last part is pertinent to our discussion and is being measured here as observing long-term changes in unemployment one way or another will tell us whether or not government digitalisation is causing some kind of unemployment or if it is decreasing it (Mankiw, 2018, 628-648). This is relevant to our discussion, because if digitisation of the government will create a large amount of unemployment the argument could be made that it is actively contributing against economic growth.

To summarise, the afore mentioned factors of inflation, taxation, interest rates, unemployment rates, a lagged GDP and the GNI, Life expectance and years spent in education encapsulated by the HDI provide us with a wide range of variables that can be controlled and dependent variables for when measuring the potential impacts digitalisation on the economy. GDP, HDI and unemployment will serve as our dependent variables. The next subchapter shall be dedicated to the measurement of the independent variable, i.e digitalisation.

2.2 Measuring Digitalisation

Having discussed the controlled variables, we can go on to discuss the independent variable, that being the one of digitalisation. There are several methods through which we can measure digitalisation. For the constraints in scope of a

Bachelor thesis, this study will use only one index, and thus this section will be dedicated to weighing them. This section of the methodology will be devoted to explaining what existing means there are of measuring digitalisation, exploring their strengths and weaknesses and justifying the use of one particular index within the methodology.

The first index that we shall explore in this section is the United Nations digital government index. This index, as its name implies ranks countries based on how good their eGovernment, or digital government is. The index measures this based on three different criteria as weighed averages for what the united nations considers to be the most important aspects of an eGovernment. To quote, the index takes into account:

> cope and quality of online services (Online Service Index, OSI), status of the development of telecommunication infrastructure (Telecommunication Infrastructure Index, TII) and inherent human capital (Human Capital Index, HCI). (United Nations, n.d.)

Thus we can see that this index incorporates different aspects relevant to our conversation. First of all, it takes into account the effect an e-government service would have in account by weighing telecommunications in that country. It circumvents a hypothetical problem of a nation having excellent e-Government infrastructure but a populace lacking in computers. Secondly, it naturally has to take into account the quality of the government services provided a given nations' e-Government. Lastly, it interesting takes human capital into account as means of assessing a country's citizens capability of accessing said services even when infrastructure is present - in other words asking if the digital infrastructure is usable by the denizens of a given country. However, it is problematic in the sense that data is only present on a bi-annual basis, meaning that there are some gaps, leading to a lower accuracy if this data would be used in a calculation.

Another method that may be used for the calculation of digitalisation can be the World Bank's digital adoption index, which has three subindexes that rank to what extent a people, businesses and government of a country have adopted digitalisation. The index is extensive in this manner, having data from 180 countries from all around the world (The World Bank, 2016). The World Bank (2016) further elaborates:

> The overall DAI is the simple average of three sub-indexes. Each sub-index comprises technologies necessary for the respective agent

> to promote development in the digital era: increasing productivity and accelerating broad-based growth for *business*, expanding opportunities and improving welfare for *people*, and increasing the efficiency and accountability of service delivery for *government*.

However, for the purpose of this study, the index is rather limiting, as it only presents the years 2014 and 2016 for analysis, and ergo does not give us enough information to work with on a multi year basis for a regression.

Similarly, IMD (2022) has an extensive World Digital Competitiveness ranking system. IMD writes:

> "The IMD World Digital Competitiveness (WDC) ranking analyses and ranks the extent to which countries adopt and explore digital technologies leading to transformation in government practices, business models and society in general." (IMD, 2022).

However, the same problem occurs as with the last set of data, - it is limited in the amount of years that are recorded. In this instance, IMD has only data dating back to 2017, meaning that though extensive, the data is not very useful for this kind of research as more years are needed to observe longterm trends. Because of these limitations, the chosen method of measuring digitalisation shall be the UN eGovernment index.

2.3 Calculating the Effect of Digitalisation Through Regression

This chapter will be dedicated to the modelling of our experiment for testing the effects of our chosen independent variable (UN eGovernment index) on our chosen dependent variables. A methodology will be outlined here which will be repeated for each country from which data has been gathered.

For the purpose of modelling the data obtained about GDP and the digitisation index, we can use an econometric model to denote a regression between these two factors. Our equation looks like so:

$$\log(y) = k + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7$$

Where*:*

$$\beta_1 = \log(\Gamma)$$

$$\beta_2 = \log(y)_{-1}$$

$$\beta_3 = \log(\partial)$$

$$\beta_4 = i$$

$$\beta_5 = \mu$$

$$\beta_6 = \Omega$$

$$\beta_7 = t$$

Γ represents a country's score on the digitalisation index, and thus β_1 represents a change over time in this index. β_2 represents a lagged variable, that variable being the past year's GDP. β_3 represents change in HDI, which is a substituted variable. β_4 represents change in interest rates. β_5 represents change in employment, β_6 a change in inflation/consumer prices and β_7 a change in tax rates. Note that the last 4 variables aren't logged because their raw form already presents as a percentage, and therefore there is no need to convert them before doing an OLS operationThe following equation will be used to examine the subject countries of Estonia, Finland, Greece and Slovakia:

$$\log(y) = k + \log(\Gamma) + \log(y)_{-1} + \log(\partial) + i + \mu + \Omega + t$$

In summary, on micro level our the independent variable is digitalisation, with controlled variables being other factors that can affect the GDP. On the macro we are comparing how digitalisation effects the GDP of four different countries, compared from most to least similar. We are changing the degree of government digitalisation, i.e we are trying to see to what extent a government has implemented technology to improve its efficacy, decrease costs or promote its interaction and provision of services. This will be measured through the United Nations eGovernment index.

Our dependent variables is economic growth, which can be measured in several different ways. Our two primary methods of measuring this growth will be the Gross Domestic Product (GDP) and the Human Development Index (HDI). GDP is a measure that takes into account all the goods and services produced and consumed within an economy over the course of a year, while the HDI is an index that takes into account GDP per capita, access to healthcare, education and life expectancy as well, to provide a more balanced image of an examined subject. The equations themselves will be calculated through a simple OLS equation that can be executed in most statistical programmes. By carrying out such an operation, we will be able to determine wether there is causality between the individual variables listed here, and thereby determine wether or not digitalisation, when taking into account other

variables which may cause a change in the GDP, causes an augmentation of the GDP. The programme of choice for the execution of this operation is Gretl, as it is open source, free and easy to use.

This same methodology can be used for measuring the effect of digitalisation on HDI and unemployment, by swapping out the location of variables. Therefore, when measuring the effect on unemployment the equation will look like so

$$\mu = k + \log(\Gamma) + \mu_{-1} + \log(\partial) + i + \Omega + t + \log(y)$$

and when we will be measuring the effect on the HDI the equation will look like so:

$$\log(\partial) = k + \log(\Gamma) + \log(\partial)_{-1} + \log(y) + i + \mu + \Omega + t$$

Note the lagged variable $\log(x)_{-1}$ changes based on the dependent variable each time. This is intentional and is supposed to control for show inertia and other factors that may effect the dependent variable but can't be controlled for in other ways (Wooldridge, 2016, pp. 0–50). Similarly, some variables have been transformed into their log form and some haven't. This is because some figures have already been presented as percentages (i.e interest or unemployment), whereas others have not. In order to make all of these comparable figures in terms of type, non-percentage variables have been converted into percentages through their log form, as to make them comparable (Duke University, n.d.).

3. Data and Empirical Models

3.1 Raw Data

For the purpose of measuring digitisation, the United Nations eGovernment index was chosen. This information was directly sourced from the United Nations. For the purpose of measuring the effect of economic growth, GDP and HDI were chosen as indicators. These are directly sourced from Eurostat. All data was grouped in respect to its nation, and arranged into a regression. Sources used for this data were the Eurostat database (European Union, 2021a), (European Union, 2021b), (European Union, 2021c), the Our World in Data Database using information from de la Escosura, L. P. (2021) and OECD. (2021), the OECD database and data, OECD. (2022). The respective data can be see aligned and transformed here:

Estonia:

	Log of GDP	Log of Lagged GDP	HDI	Tax Rates	Intest Rates	Log of HICP	Unem. Rates	Log of Digit.
2003	4,10931188	4,07749871	-0,0899094	0,90406318	0,52344209	1,81016528	1,01283722	-0,1568918
2004	4,13789822	4,10931188	-0,0856568	0,89594581	0,46553051	1,82314805	1,00432137	-0,1531126
2005	4,17741817	4,13789822	-0,0798766	0,83862471	0,44769947	1,84067056	0,90308998	-0,1338722
2006	4,21788383	4,17741817	-0,0762380	0,84364071	0,55460943	1,85955857	0,77085201	-0,1289769
2007	4,24961165	4,21788383	-0,0726296	0,86316791	0,72387908	1,88789848	0,66275783	-0,1240816
2008	4,22673133	4,24961165	-0,0716041	0,88512036	0,85060494	1,93171206	0,74036268	-0,1191864
2009	4,15804268	4,22673133	-0,0726296	0,86640703	0,80289866	1,93257522	1,13033376	-0,1286176
2010	4,16852989	4,15804268	-0,0695604	0,81482897	0,29997772	1,94428522	1,22271647	-0,1570601
2011	4,19898131	4,16852989	-0,0655015	0,79390927	0,25905844	1,96581295	1,08990511	-0,1273300
2012	4,21277869	4,19898131	-0,0629838	0,81673306	-0,0007200	1,98376156	1	-0,0976000
2013	4,21906557	4,21277869	-0,0609802	0,85312698	-0,1898840	1,99764845	0,93449845	-0,0924339
2014	4,23195102	4,21906557	-0,0599818	0,86493543	-0,1971624	1,99969588	0,86923171	-0,0872679
2015	4,23992481	4,23195102	-0,0570004	0,88826640	-0,3916950	2	0,79239168	-0,0831967
2016	4,25341797	4,23992481	-0,0550240	0,87056126	-0,7919127	2,00346053	0,83250891	-0,0791256
2017	4,2778704	4,25341797	-0,0530567	0,85535443	-1,0172314	2,01903316	0,76342799	-0,0752113
2018	4,29546373	4,2778704	-0,0510982	0,87140473	-0,9868748	2,03362477	0,73239375	-0,0712969
2019	4,31289846	4,29546373	-0,0496351	0,86088529	-1,1622430	2,04336227	0,64345267	-0,0474047

Finland:

	Log of GDP	Log of Lagged GDP	HDI	Tax Rates	Intest Rates	Log of HICP	Unem. Rates	Log of Digit.
2003	5,22555789	5,21694165	-0,0680338	16,380339	2,333467	1,91094440	0,95424250	-0,1185468
2004	5,24255832	5,22555789	-0,0665127	16,083599	2,106325	1,91158370	0,94448267	-0,0841307
2005	5,25446614	5,24255832	-0,0619809	16,066235	2,184675	1,91492464	0,92427928	-0,0845421
2006	5,27161394	5,25446614	-0,0599818	15,993915	3,079225	1,92043640	0,88649072	-0,0982394
2007	5,29403965	5,27161394	-0,0584885	16,227976	4,277608	1,92721633	0,83884909	-0,1119368
2008	5,29743111	5,29403965	-0,0579919	15,990528	4,634233	1,94393946	0,80617997	-0,1256341
2009	5,26086742	5,29743111	-0,0574958	14,583459	1,228358	1,95094871	0,91381385	-0,1412941
2010	5,27448806	5,26086742	-0,0560111	14,406063	0,81095	1,95822931	0,92427928	-0,1569541
2011	5,28541394	5,27448806	-0,0545314	14,815301	1,3906	1,97243427	0,89209460	-0,1136348
2012	5,27930160	5,28541394	-0,0530567	14,525684	0,5731834	1,98592022	0,88649072	-0,0703154
2013	5,27536779	5,27930160	-0,0510982	15,072851	0,2206667	1,99545968	0,91381385	-0,0717525
2014	5,27378021	5,27536779	-0,0491485	15,214817	0,2099333	2,00069431	0,93951925	-0,0731895
2015	5,27613469	5,27378021	-0,0481769	15,313764	-0,0193666	2	0,97312785	-0,0639392
2016	5,28817631	5,27613469	-0,0486624	15,140816	-0,2636917	2,00169045	0,94448267	-0,0546890
2017	5,30182402	5,28817631	-0,0472075	15,202761	-0,32905	2,00530923	0,93449845	-0,0547333
2018	5,30675539	5,30182402	-0,0467236	14,764782	-0,3220917	2,01038477	0,86923171	-0,0547776
2019	5,31255244	5,30675539	-0,0452752	14,763528	-0,3563333	2,01527590	0,82607480	-0,0396269

Greece:

	Log of GDP	Log of Lagged GDP	HDI	Tax Rates	Intest Rates	Log of HICP	Unem. Rates	Log of Digit.
2003	5,33360262	5,30913939	-0,0793549	7,314145	2,333467	1,89828627	9,8	-0,2676947
2004	5,35504423	5,33360262	-0,0741724	7,247946	2,106325	1,91121089	10,6	-0,2533191
2005	5,35763835	5,35504423	-0,0690509	8,149888	2,184675	1,92608508	10	-0,2276049
2006	5,38151794	5,35763835	-0,0660068	7,452876	3,079225	1,94021755	9	-0,2326552
2007	5,39550793	5,38151794	-0,0670191	7,444134	4,277608	1,95303445	8,4	-0,2377055
2008	5,39404977	5,39550793	-0,0629838	7,348259	4,634233	1,97104379	7,8	-0,2427558
2009	5,37495847	5,39404977	-0,0619809	7,586295	1,228358	1,97685414	9,6	-0,2431549
2010	5,35048836	5,37495847	-0,0629838	7,117935	0,81095	1,99681802	12,7	-0,2435540
2011	5,30400986	5,35048836	-0,0644927	7,354359	1,3906	2,01013027	17,9	-0,2032481
2012	5,27208771	5,30400986	-0,0629838	8,614622	0,5731834	2,01460453	24,5	-0,1629421
2013	5,26102102	5,27208771	-0,0619809	7,802757	0,2206667	2,01089331	27,5	-0,1553042
2014	5,26308213	5,26102102	-0,0579919	8,544734	0,2099333	2,00479411	26,5	-0,1476664
2015	5,26222961	5,26308213	-0,0570004	8,282324	-0,0193666	2	24,9	-0,1540941
2016	5,26010861	5,26222961	-0,0584885	8,918886	-0,2636917	2,00008685	23,6	-0,1605219
2017	5,26482608	5,26010861	-0,0560111	8,807691	-0,32905	2,00496588	21,5	-0,1332969
2018	5,27201227	5,26482608	-0,0550240	9,162786	-0,3220917	2,00834462	19,3	-0,1060718
2019	5,27977527	5,27201227	-0,0515870	8,527204	-0,3563333	2,01055435	17,3	-0,1009216

Slovakia:

	Log of GDP	Log of Lagged GDP	HDI	Tax Rates	Interest Rates	Log of HIC	Unemployn	Log of Digi
2003	4,67967677	4,65642787	-0,1090204	6,571003	5,89	1,86899690	17,6	-0,2773660
2004	4,70201758	4,67967677	-0,1045774	5,965769	4,384167	1,90031249	18,2	-0,2545582
2005	4,72987075	4,70201758	-0,0990869	5,879773	2,643333	1,91227521	16,3	-0,2301280
2006	4,76527281	4,72987075	-0,0942041	6,009444	4,0825	1,93038861	13,4	-0,2300715
2007	4,80993795	4,76527281	-0,0883098	6,086234	4,025	1,93851972	11,1	-0,2300149
2008	4,83349899	4,80993795	-0,0846001	6,398233	3,854167	1,95530282	9,5	-0,2299584
2009	4,80913463	4,83349899	-0,0835460	5,501779	1,228358	1,95927995	12,0	-0,2393897
2010	4,83564048	4,80913463	-0,0803989	5,281097	0,81095	1,96232197	14,4	-0,2488210
2011	4,84694667	4,83564048	-0,0767559	5,388499	1,3906	1,97968492	13,6	-0,2250230
2012	4,85280559	4,84694667	-0,0741724	5,442942	0,5731834	1,99563519	14,0	-0,2012250
2013	4,85563967	4,85280559	-0,0731432	6,004973	0,2206667	2,00194994	14,2	-0,2062526
2014	4,86731307	4,85563967	-0,0721165	6,496105	0,2099333	2,00151737	13,2	-0,2112802
2015	4,88939359	4,86731307	-0,0705810	6,948225	-0,0193666	2	11,5	-0,2196480
2016	4,89770294	4,88939359	-0,0690509	7,003203	-0,2636917	1,99791036	9,7	-0,2280158
2017	4,91045631	4,89770294	-0,0680338	7,049546	-0,32905	2,00389116	8,1	-0,1867031
2018	4,92663050	4,91045631	-0,0665127	7,116917	-0,3220917	2,01477247	6,5	-0,1453903
2019	4,93780064	4,92663050	-0,0655015	7,170272	-0,3563333	2,02665581	5,8	-0,1261751

3.2 Data Modeling and Result

This part of the paper will be dedicated to displaying the various results of the OLS operations executed in Gretl based on data displayed in the previous subchapter.

Estonia: OLS, using observations 2003-2019 (T = 17)

Dependent variable: GDP

	Coefficient	Std. Error	t-ratio	p-value	
const	3.40475	0.417935	8.147	<0.0001	***
HDI	1.38865	1.05997	1.310	0.2226	
Taxes	−0.374302	0.0603311	−6.204	0.0002	***
Interest	−0.0191812	0.00621407	−3.087	0.0130	**
HCIP	0.0666773	0.130365	0.5115	0.6213	
Unemployment	−0.196537	0.0182679	−10.76	<0.0001	***
Digitalisation	−0.510499	0.142858	−3.573	0.0060	***
Lagged GDP	0.289099	0.0689071	4.195	0.0023	***

Mean dependent variable	4.216928	S.D. dependent var	0.054707
Sum squared resid	0.000171	S.E. of regression	0.004361
R-squared	0.996425	Adjusted R-squared	0.993645
F(7, 9)	358.3760	P-value(F)	2.81e-10
Log-likelihood	73.67915	Akaike criterion	−131.3583
Schwarz criterion	−124.6926	Hannan-Quinn	−130.6957
rho	−0.478109	Durbin-Watson	2.897308

Finland: OLS, using observations 2003-2019 (T = 17)
Dependent variable: GDP

	Coefficient	Standard Error	t-ratio	p-value	
constant	7.07822	1.43972	4.916	0.0008	***
Lagged GDP	−0.157661	0.233704	−0.6746	0.5169	
HDI	4.68395	1.38867	3.373	0.0082	***
Taxes	−0.00218192	0.0100143	−0.2179	0.8324	
Inteterest	0.00333081	0.00589925	0.5646	0.5861	
HICP	−0.247419	0.266785	−0.9274	0.3779	
Unemployment	−0.218547	0.0918058	−2.381	0.0412	**
Digitalisation	−0.00277975	0.144527	−0.01923	0.9851	

Mean dependent var	5.277666	S.D. dependent var	0.022799
Sum squared resid	0.000512	S.E. of regression	0.007540
R-squared	0.938471	Adjusted R-squared	0.890615
F(7, 9)	19.61036	P-value(F)	0.000091
Log-likelihood	64.37135	Akaike criterion	−112.7427
Schwarz criterion	−106.0770	Hannan-Quinn	−112.0801
rho	0.295182	Durbin-Watson	1.381195

Greece: OLS, using observations 2003-2019 (T = 17)
Dependent variable: GDP

	Coefficient	Std. Error	t-ratio	p-value	
constant	3.75392	0.606021	6.194	0.0002	***
GDP_1	0.550388	0.157603	3.492	0.0068	***
HDI	2.68467	0.814031	3.298	0.0093	***
Taxes	−0.00502607	0.00580138	−0.8664	0.4088	
Interest	0.00638532	0.00228136	2.799	0.0207	**
HICP	−0.585618	0.205112	−2.855	0.0189	**
Unemployment	−0.00100155	0.000973251	−1.029	0.3303	
Digitalisation	−0.0603554	0.153893	−0.3922	0.7040	

Mean dependent var	5.316586	S.D. dependent var	0.052862
Sum squared resid	0.000445	S.E. of regression	0.007032
R-squared	0.990046	Adjusted R-squared	0.982305
F(7, 9)	127.8844	P-value(F)	2.78e-08
Log-likelihood	65.55809	Akaike criterion	−115.1162
Schwarz criterion	−108.4505	Hannan-Quinn	−114.4536
rho	−0.327300	Durbin-Watson	2.597998

Slovakia: OLS, using observations 2003-2019 (T = 17)
Dependent variable: GDP

	Coefficient	Std. Error	t-ratio	p-value	
constant	6.94141	1.02203	6.792	<0.0001	***
Lagged GDP	−0.230498	0.165564	−1.392	0.1973	
HDI	6.57440	1.32819	4.950	0.0008	***
Taxes	0.000536853	0.00295080	0.1819	0.8597	
Interest	0.00116137	0.00257658	0.4507	0.6628	
HICP	−0.203180	0.391042	−0.5196	0.6159	
Unemployment	−0.00507481	0.00161558	−3.141	0.0119	**
Digitalisation	0.0395034	0.115624	0.3417	0.7405	

Mean dependent var	4.832338	S.D. dependent var	0.075986
Sum squared resid	0.000283	S.E. of regression	0.005608
R-squared	0.996936	Adjusted R-squared	0.994553
F(7, 9)	418.3352	P-value(F)	1.40e-10
Log-likelihood	69.40427	Akaike criterion	−122.8085
Schwarz criterion	−116.1428	Hannan-Quinn	−122.1460
rho	−0.292548	Durbin-Watson	2.409200

Estonia: OLS, using observations 2004-2019 (T = 16)
Dependent variable: HDI

	Coefficient	Std. Error	t-ratio	p-value	
const	0.231405	0.249607	0.9271	0.3810	
GDP	−0.0639321	0.0496976	−1.286	0.2343	
Taxes	−0.0474398	0.0186162	−2.548	0.0343	**
Interest	−0.00373075	0.000891730	−4.184	0.0031	***
HICP	0.0399463	0.0249573	1.601	0.1481	
Digitalisation	−0.0616158	0.0373645	−1.649	0.1377	
Unemployment	−0.0216406	0.0115525	−1.873	0.0979	*
Lagged HDI	0.762870	0.227214	3.358	0.0100	***

Mean dependent var	−0.065216	S.D. dependent var	0.010757
Sum squared resid	5.02e-06	S.E. of regression	0.000792
R-squared	0.997110	Adjusted R-squared	0.994581
F(7, 8)	394.2665	P-value(F)	1.63e-09
Log-likelihood	97.10026	Akaike criterion	−178.2005
Schwarz criterion	−172.0198	Hannan-Quinn	−177.8840
rho	−0.447937	Durbin's h	−4.295576

Finland: OLS, using observations 2004-2019 (T = 16)
Dependent variable: HDI

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.257768	0.296954	−0.8680	0.4107	
GDP	0.0241191	0.0465749	0.5179	0.6186	
Interest	−0.000870728	0.000928804	−0.9375	0.3760	
Taxes	0.00150098	0.00174642	0.8595	0.4151	
Digitalisation	−0.0115898	0.0250316	−0.4630	0.6557	
Unemployment	−0.00654666	0.0175759	−0.3725	0.7192	
HICP	0.0465138	0.0452494	1.028	0.3341	
Lagged HDI	0.579890	0.251040	2.310	0.0497	**

Mean dependent var	−0.053896	S.D. dependent var	0.006213
Sum squared resid	7.97e-06	S.E. of regression	0.000998
R-squared	0.986232	Adjusted R-squared	0.974185
F(7, 8)	81.86439	P-value(F)	8.20e-07
Log-likelihood	93.39518	Akaike criterion	−170.7904
Schwarz criterion	−164.6097	Hannan-Quinn	−170.4739
rho	−0.215934	Durbin's h	NA

Greece: OLS, using observations 2004-2019 (T = 16)
Dependent variable: HDI

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.369414	0.390427	−0.9462	0.3718	
GDP	0.0655677	0.0691682	0.9479	0.3709	
Taxes	0.000263394	0.00149286	0.1764	0.8643	
Interest	−0.000590927	0.000795634	−0.7427	0.4789	
HICP	0.00205225	0.0421640	0.04867	0.9624	
Digitalisation	0.0678411	0.0320372	2.118	0.0671	*
Unemployment	0.000118379	0.000326586	0.3625	0.7264	
Lagged HDI	0.561436	0.202839	2.768	0.0244	**

Mean dependent var	−0.061860	S.D. dependent var	0.005740
Sum squared resid	0.000026	S.E. of regression	0.001803
R-squared	0.947383	Adjusted R-squared	0.901343
F(7, 8)	20.57743	P-value(F)	0.000162
Log-likelihood	83.93459	Akaike criterion	−151.8692
Schwarz criterion	−145.6885	Hannan-Quinn	−151.5527
rho	−0.281551	Durbin's h	−1.926607

Slovakia: OLS, using observations 2004-2019 (T = 16)
Dependent variable: HDI

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.595323	0.254282	−2.341	0.0473	**
GDP	0.0879902	0.0199475	4.411	0.0023	***
Taxes	−0.000488883	0.000348877	−1.401	0.1987	
Interest	−0.000186199	0.000506863	−0.3674	0.7229	
Digitalisation	−0.0113679	0.0238874	−0.4759	0.6469	
HICP	0.0590120	0.0968242	0.6095	0.5591	
Unemployment	0.000199146	0.000248288	0.8021	0.4457	
Lagged HDI	0.342201	0.344450	0.9935	0.3496	

Mean dependent var	−0.079412	S.D. dependent var	0.012014
Sum squared resid	2.72e-06	S.E. of regression	0.000583
R-squared	0.998744	Adjusted R-squared	0.997645
F(7, 8)	908.6861	P-value(F)	5.83e-11
Log-likelihood	101.9979	Akaike criterion	−187.9958
Schwarz criterion	−181.8150	Hannan-Quinn	−187.6793
rho	−0.101114	Durbin's h	NA

Estonia: OLS, using observations 2004-2019 (T = 16)
Dependent variable: Unemployment

	Coefficient	Std. Error	t-ratio	p-value	
const	16.8186	3.15769	5.326	0.0007	***
GDP	−4.22702	0.404013	−10.46	<0.0001	***
HDI	−1.00321	6.21994	−0.1613	0.8759	
Taxes	−2.01313	0.378792	−5.315	0.0007	***
Interest	−0.0975085	0.0290997	−3.351	0.0101	**
HICP	1.78865	0.649600	2.753	0.0249	**
Digitalisation	−2.47721	0.600442	−4.126	0.0033	***
Lagged unem.	−0.209787	0.0776212	−2.703	0.0270	**

Mean dependent var	0.880765	S.D. dependent var	0.170785
Sum squared resid	0.003710	S.E. of regression	0.021536
R-squared	0.991519	Adjusted R-squared	0.984099
F(7, 8)	133.6162	P-value(F)	1.19e-07
Log-likelihood	44.25050	Akaike criterion	−72.50099
Schwarz criterion	−66.32028	Hannan-Quinn	−72.18449
rho	−0.548132	Durbin's h	−2.306520

Finland: OLS, using observations 2004-2019 (T = 16)
Dependent variable: Unemployment

	Coefficient	Std. Error	t-ratio	p-value	
const	10.6712	4.03079	2.647	0.0294	**
GDP	−2.11640	0.577036	−3.668	0.0063	***
HDI	4.14043	4.33240	0.9557	0.3672	
Taxes	0.0441616	0.0230418	1.917	0.0916	*
Interest	−0.0211351	0.0126619	−1.669	0.1336	
HICP	0.293356	0.673821	0.4354	0.6748	
Digitalisation	−0.842298	0.295539	−2.850	0.0215	**
Lagged Unem.	0.362826	0.138948	2.611	0.0311	**

Mean dependent var	0.901107	S.D. dependent var	0.046889
Sum squared resid	0.001879	S.E. of regression	0.015328
R-squared	0.943009	Adjusted R-squared	0.893142
F(7, 8)	18.91041	P-value(F)	0.000220
Log-likelihood	49.69171	Akaike criterion	−83.38341
Schwarz criterion	−77.20270	Hannan-Quinn	−83.06691
rho	−0.121541	Durbin's h	−0.584809

Greece: OLS, using observations 2004-2019 (T = 16)
Dependent variable: Unemployment

	Coefficient	Std. Error	t-ratio	p-value	
const	−177.398	284.729	−0.6230	0.5506	
GDP	−13.6323	43.1449	−0.3160	0.7601	
HDI	−642.946	203.676	−3.157	0.0135	**
Taxes	0.0190481	0.825264	0.02308	0.9822	
Interest	−0.335979	0.526253	−0.6384	0.5410	
HICP	108.623	26.1258	4.158	0.0032	***
Digitalisation	3.14782	22.8014	0.1381	0.8936	
Lagged Unem.	0.752701	0.159701	4.713	0.0015	***

Mean dependent var	16.94375	S.D. dependent var	7.187579
Sum squared resid	8.039635	S.E. of regression	1.002474
R-squared	0.989625	Adjusted R-squared	0.980547
F(7, 8)	109.0142	P-value(F)	2.66e-07
Log-likelihood	−17.19738	Akaike criterion	50.39475
Schwarz criterion	56.57546	Hannan-Quinn	50.71126
rho	−0.080842	Durbin's h	−0.420304

Slovakia: OLS, using observations 2004-2019 (T = 16)
Dependent variable: Unemployment

	Coefficient	Std. Error	t-ratio	p-value	
const	−623.584	375.321	−1.661	0.1352	
GDP	43.3685	48.4499	0.8951	0.3969	
HDI	−900.371	429.309	−2.097	0.0692	*
Taxes	−1.67039	0.498412	−3.351	0.0101	**
Interest	−1.16168	0.367590	−3.160	0.0134	**
Digitalisation	−45.1131	15.2603	−2.956	0.0183	**
HICP	176.998	63.9835	2.766	0.0244	**
Lagged Unem.	0.559624	0.122994	4.550	0.0019	***

Mean dependent var	11.96875	S.D. dependent var	3.405626
Sum squared resid	3.407416	S.E. of regression	0.652631
R-squared	0.980414	Adjusted R-squared	0.963277
F(7, 8)	57.20865	P-value(F)	3.32e-06
Log-likelihood	−10.32994	Akaike criterion	36.65988
Schwarz criterion	42.84059	Hannan-Quinn	36.97638
rho	−0.208343	Durbin's h	−0.957227

4. Result and Interpretation

In the calculation of the regressions, an unexpected result came to be - that is specifically, that the OLS regressions have found digitalisation to be either statistically insignificant or detrimental to GDP growth, and largely insignificant to the development of a country's HDI score. However, they have found digitalisation to be largely beneficial to reducing unemployment. This chapter of the paper will be dedicated about discussing the various effects individual variables have had on the GDP, HDI, and unemployment in Estonia, Finland, Greece and Slovakia.

Starting with the most glaring results of the calculation: we can see that digitalisation is not represented in the way the hypothesis of this paper would have predicted. In the case of Estonia, digitalisation has a statistically significant p-value, but was shown to have a negative impact on GDP growth. In the three remaining cases of Finland, Greece, and Slovakia, digitisation fails to to attain a statistically significant p-value . This seems to fly in the face of the hypothesis, which suggested that digitisation would have a positive impact on the GDP, especially since the two variables correlate.

The OLS did yield several interesting results however. In all cases, HDI has been shown to have a significant impact on GDP growth. In all cases, the p-value has shown the value to be statistically relevant, and in all cases the impact of the HDI on GDP growth is demonstrated to be positive. This is not unexpected, as life expectancy, income, and human capital are all factors that one would expect to bolster economic growth.

In all cases except Greece, unemployment has been shown to be a statistically significant detriment to GDP growth. In the case of Greece, another notable result is that increase in interest rates have a positive causality with GDP growth, whereas an increase in prices has a negative effect on GDP growth. In Estonia, the reverse was true, where lower interest rates proved negative for GDP growth and higher prices were a boon. Taxes had a statistically significant effect only in Estonia, where they proved to have a negative effect on the GDP.

Observing the HDI, we can that there were similarly negligible effects when it comes to digitalisation, we can see no consistent effect. There is only one country in

the chosen data sets that has been demonstrated to have some form of causality between digitalisation and positive change in the HDI, and therefore we can similarly say that the results for the HDI are inconclusive, with the lagged HDI variable showing that there may be other factors at play. Furthermore there were other stronger relationships found between HDI and controlled variables, such as those between taxation, unemployment, and GDP. Due to the vastly different influences on the HDI of each chose country, we can deduce no observable trend between HDI and digitalisation.

When it comes to unemployment, however, the story is very different. Probably the most positives news for digitalisation of the government is that it has been shown to reduce unemployment in three of the four chosen countries for this study, those being Estonia, Finland and Slovakia, Greece being the only country where a relationship between unemployment and digitalisation was not observed. Other factors observed that reduce unemployment were, like with the HDI, variable from country to country, with unemployment rates being affected by everything from HDI, taxes, interest rates, the inertial unemployment variable and inflation.

To conclude this section, it can be said that though the data shows no strong observable relationship between GDP or HDI and government digitalisation, we can see a clear trend of positive causality between government digitalisation and employment based on the data presented and processed for this research.

5. Discussion and Conclusion

How can we explain the results that we have attained from the research? How is it that Digitalisation, from our results, seems to have a negligible impact on the GDP , and when it does, it is negative? Why do we see little to no impact on the HDI as a result of digitalisation? What is the significance of the strong relationship between digitalisation of the government and lower unemployment rates? This chapter will be dedicated to explaining the potential reasons for the quantitate results of this thesis while also exploring the significance and further research that the results of this study imply.

5.1 GDP, HDI and Digitalisation

In terms of what greater economic drivers may play a larger role than digitalisation in these countries, we should move to a cases by case scenario. In the case of Estonia and Greece, we can observe that monetary policy is a determinant of growth. In the case of Greece, an increase in interest rates seems to suggest larger growth while an increase in prices would suggest a decrease in growth, indicating that an issue that may plaguing the Greek economy more than digitalisation would be increasing prices and a lack of saving among Greeks. Estonia is the opposite case, as there seems to be a severe lack in the supply of money, with increasing interest rates slowing down the economy. This can be further confirmed by the fact taxation decreases growth as well, which could be indicating that a constraint in the money supply by taxation in Estonia is holding the economy back.

A commonality among Finland and Slovakia was that an increase in unemployment in these economies had a statistically significant impact on the economies of these countries. indicating that a problem more pressing than digitalisation in these countries could be an underutilisation of unemployed people. The fact that these countries experience a decrease in GDP when an increase in unemployment is present would indicate that both Finland and Slovakia have very right labour markets in segments of the economy that drive the countries forward - in

other words, the data seems to indicate that they are suffering from something akin to brain drain where there is a lack of needed workers.

This theory seems to be corroborated by the fact an increase in HDI saw a positive causality with all the GDP of all chose nations. We could hypothesise that the two components of the HDI - the years spent in education (i.e human capital) and life expectancy could be contributing to this through their implications about a give country's labour market. If a country's workers become more qualified and can live (and thus work) longer, it stands to reason that a country's economy would do better.What we can thus take from this is that there are larger determinants of a country's growth than digitalisation, those being money supply and the labour market.

The causal relationship between GDP and HDI is only slightly more optimistic - similarly to the GDP, there are no statistically relevant causalities between HDI and government digitisation save for the case of Greece, where there is a positive relationship between increasing digitalisation and increasing HDI. This indicates that the direct causality between digitalisation and HDI seems to be similarly weak to the one between digitalisation and the GDP, with various other factors being shown as more influential to the HDI compared to digitalisation. A further interesting fact is that there is no reverse relationship with the HDI and the GDP either - while there is a causality for higher GDP from higher HDI, the reverse does not seem to hold in this case.

Though the data provided by this research is by no means comprehensive enough to proclaim that an improvement in a country's eGovernment won't yield an improvement in GDP or HDI under any conditions, it challenges the notion that an improvement in eGovernment is a universal guarantor for economic growth. Rather, it seems to suggest that if a country wishes to improve its economic growth, there are better candidates for attention, those being human capital, monetary policy and labour markets, all of which have had a greater demonstrable effect on the economy than digitalisation.

5.2 Unemployment and Digitalisation

One very clear result of the research is that we can see a positive relationship between unemployment and digitalisation. In three out of four countries, we have seen that an increase in government digitalisation has yielded a decrease in unemployment rates. This seems to indicate that in some economies, the quality of the eGovernment would coincide with some form of economic wellbeing for the overall population, though not necessarily economic growth per se.

The implications of this seem to re-affirm some aspects of the institutional argument, that open economic institutions will yield greater prosperity to society. Why? A better eGovernment, in the terms of the index that has been used to measure it, which includes the ability of the people to use said services, availability of technology, and the quality of eGovernment services would mean that if people want to get anything relating to to government done - i.e apply for unemployment support, or open business, there would be less barriers standing in their way, as they would not have travel, wait or fill out paperwork. Rather, the given person would be able to do all those things from the comfort of their home, using a device such as a phone or a computer to access these services.

The significance of this cannot be understated, as we are observing a potential relationship between a specific set of policies that government and the phenomenon of unemployment. Though the sample size of countries is too small to determine if certain policies should be carried out now, the results indicate that more research should be conducted into the question of unemployment and digitalisation of the government. This is because of the trend unearthed by this study would be proven, it would mean that there is a prove-able set of policies that the government can apply to reduce unemployment. These would be improving human capital (education in the field of ICT), creating a broader technical access to eGovernment services, and lastly, improving the quality of the said eGovernment services by doing things such as updating websites in terms of user friendliness and the efficacy of government employees using said technologies.

5.3 Concluding Thoughts

In terms of a methodological auto-critique, there can be several explanations for why the OLS did not yield the expected results for GDP and HDI. For starters, it is possible that the scope of the work (i.e sample size) of four countries is not enough to observe a phenomenon such as digitalisation. It could be that for unforeseen reasons, the chosen countries are in a condition where digitalisation is not in place to improve the economy, as there may be larger obstacles for growth in these countries. Estonia and Slovakia are both countries recovering from command-style economies, while Greece suffered the brunt of an enormous financial crisis. For this reason, it might be better for future studies to focus more on developed economies that may not be struggling with the specific issues of the chosen countries.

It is also possible that the chosen indicator for digitalisation of the government has been a poor choice, as for an unforeseen reason it may not be capturing the essential elements of public digitalisation necessary for this type of analysis. Potential substitutes for this indicator could be a different index (though that might be difficult to find given the gaps presented in most mainstream indexes used to measure digitalisation), or a different indicator all-together such as the sum of money spent by a given government on public digitalisation, which may reveal a different trend from the chosen indicator. If this were to be the case, it would indicate that the the current UN government index is lacklustre, at least in this field of econometric analysis. A recommendation for a future paper that would have a greater scope than bachelor thesis would be to focus on a greater number countries and to use a greater number of measurers for digitalisation.

However, despite these shortcomings, the results of the study are not entirely unreasonable - though no strong relationship between GDP or HDI and digitalisation was found in the study (and wether that is refutation of literature or a methodological fluke is up to discussion), it did yield the expected results in terms of digitalisations relationship to unemployment, or in other words, we do see a positive causal relationship between government digitalisation and unemployment.

In conclusion, this paper finds that research into the question of causality between government digitalisation and economic growth remains inconclusive. The data processed for research in this paper has found that there are far greater factors that drive an economy forward compared the government digitalisation, such as those of human capital, labour markets and monetary policy. This is not to say that digitalisation cannot bring economic growth, but rather that data used in this paper have not found a link between public digitalisation and economic growth. The only verifiable relationship that this paper has found is that of digitalisation of the government and decreasing unemployment.

The lack of a causality between an improvement in GDP or HDI and improving eGovernment is sure to add to the growing discussion in the field of digitalisation and eGovernment, chiefly in the sense that it will challenge the dominant paradigm that digitalisation of the public sector causes economic growth, while also challenging the notion that an institutional approach can be used to look at the relationship between public digitalisation and economic growth. Furthermore, the relationship between digitalisation and unemployment seems to indicate that while there may not be direct measures for the government to influence the performance of its economy as a whole through the quality of its eGovernment, there may be indirect ways for the government to influence to economy through these means. For this reason, the results of this research remain inconclusive, as out of the results only found one causality between eGovernment and economic improvement.

Resumé

Tento výskumný dokument bol zameraný na preskúmanie vzťahu medzi ekonomickým rastom a digitalizáciou verejného sektora. Jeho prístup vychádza z analýzy *ex ante* z novej Inštitucionálnej ekonomickej školy, ktorej priekopníkmi sú Acemoglu & Robinson (2013) v knihe *Why Nations Fail*. Táto škola vyzdvihuje dôležitosť inštitúcií pre fungovanie ekonomiky, pričom začiatky sú prostriedkom, pomocou ktorého môžu mať účastníci ekonomiky konkrétne istoty. Z tohto teoretického základu vychádza hypotéza tejto práce, že v modernej digitálnej ekonomike je nevyhnutné, aby vláda mala robustnú elektronickú verejnú správu, aby mohla poskytnúť otvorené inštitucionálne podmienky, ktoré moderná digitálna ekonomika potrebuje, a teda predpokladá, že lepšia eGovernment môže byť príčinou lepšieho hospodárskeho rastu, ktorý bol odmeraný spôsobom HDP, HDI, a úrovní nezamestnanosti.

Na overenie tejto hypotézy práca používa ekonometrický prístup, analyzuje štyri rôzne krajiny podobnej veľkosti, dve postkomunistické (Slovensko a Estónsko) a dve „západné“ (Fínsko a Grécko). Ďalším kľúčovým faktorom pri výbere týchto krajín je, že ich možno rozdeliť aj do dvoch kategórií, na krajiny, o ktorých *ex ante* vieme, že majú dobrú štruktúru eGovernmentu (Estónsko a Fínsko) a na tie, o ktorých vieme, že majú horšiu štruktúru eGovernmentu (Slovensko a Grécko). Ekonometrická analýza použila metódu obyčajných najmenších štvorcov (OLS), kontrolujúc premenné inflácie, HDI, nezamestnanosti, daní, úrokov a oneskoreného HDP, aby sa zachytili akékoľvek ďalšie potenciálne príčiny rastu. Po HDP sa podobná metóda použila na určenie, či je možné nájsť kauzalitu medzi vládnou digitalizáciou a HDI alebo nezamestnanosťou.

Z výsledkov OLS by sa mohlo zdať, že hypotéza bola len čiastočne správna. Výsledky ukazujú, že zatiaľ čo vládna digitalizácia má zanedbateľný makroekonomický efekt z hľadiska HDP alebo HDI, zistil sa silný vzťah medzi nezamestnanosťou a vládnou digitalizáciou, kde by zvýšená digitalizácia znížila nezamestnanosť. Na základe zistení, a tým že rozsah práce je malý, autor navrhuje aby sa v záujme budúceho výskumu v tejto téme používali rôzne indikátory vládnej digitalizácie a zahrnulo sa viac krajín, aby sme si overili, či eGovernment skutočne

nie je príčinou zvýšeného ekonomického rastu, resp. či výsledky dosiahnuté v tejto štúdii nie sú výsledkom metodologickej náhody, alebo či nedokazujú akýkoľvek vplyv digitalizácie na HDP alebo HDI.

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C 4 V d 6 n Q 7 v f X h B A h P 4 Z W k m I 6 H f E 2 I A T E g n S - diKyNmrRyKOIagpocHv3bUJ9La6n7RREvxYIJLwsvSZPoesi2~bXg0giP3pisb oIiD572zHsXIH5vBllmBxL2ERg63~nJuaUakbdurpQd7k7SF6AuT2ZsL6pwIc O C w d 2 4 B T O q T 5 H f ~ j v G I y O Z M m V x 2 V 8 g _ _ & K e y - P a i r - Id=APKAJLOHF5GGSLRBV4ZA

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