Programmi RITA tegevuse 1 projekt

„COVID-19 seotud majandusmõjude ning nende pehmendamiseks mõeldud poliitikameetmete tõhususe hindamine“

Fiscal Policy Impact Assessment.

Literature review[1]

[1] Prepared by Gaygysyz Ashyrov, Sheriff Tolulope Ibrahim and Lenno Uusküla

Executive summary

In the background of the Recovery Plan of the European Union, Estonian Government is planning additional investments into various sectors in the economy. This paper gives an overview of the effects of investments into green economy, health care and the digitalization of the economy and well-being.

Green economy primarily aims to improve human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Green policies should be introduced to maintaining environmental quality via reducing carbon emissions, sustaining and advancement of energy security by varying the energy mix, while offering sustainable economic growth by promoting competitiveness, creating employment opportunities and innovation in new industries. First, evidence on green policies in different countries provide support for a positive association between green investments and macroeconomic indicators such as gross domestic product and public sector revenues. Second, green policies have induced positive net employment, in terms of jobs/megawatt, via creation of jobs in green industries and destruction of jobs in brown industries. Especially, EU wide studies have shown net positive employment due to efficient job markets. Third, green investments help to reduce carbon emissions, hence mitigate the consequences of climate change.

Health care expenditures exhibit a positive relationship with health outcomes such that the more resources committed towards health care the better the societal health outcomes. Several empirical studies across the globe have been carried out to ascertain the nature of the relationship between government health care expenditures and health outcomes. Opposite results relate to the inefficiencies in government spending on health care or sometimes due to bad governance. Thus, efficiency and monitoring are as important as the increase in government spending on health care, increase in health care spending in isolation cannot improve the societal health outcome.

Digital transformation may enable governments to generate public value by promoting transparency, accountability, and collaborative governance. Open government data has a crucial function in achieving successful public sector digitalization. Furthermore, for assessing current state and developing digitalization in public sector, quantification of economic consequence of open government data is of the utmost importance. First, implementation of e-government has a positive impact on economy by raising economic growth, developments in infrastructure, reducing administrative burdens and costs, increasing efficiency, curbing illegal activities such as corruption and informal economy. Second, public sector digitalization via expanding open government data has a significant market size and is forecasted to have larger market size. Public sector digitalization has so far contributed substantially to the economic growth, employment, efficiency gains, cost savings and citizens' well-being.

Contents

1. Green investments

1.1. Motivation, definition and determinants

Climate change is an externality that can potentially be disastrous and it is a collective action challenge for world economies (International Monetary Fund, 2008). Since this growing environmental problem is expected to affect national economies, governments are urged to prepare and implement strategies to mitigate it. Accordingly, for tackling this collective action problem, countries have signed international agreements such as the Paris Agreement which is an agreement within the United Nations Framework Convention on Climate Change, on climate change mitigation, adaptation, and finance, entered into force in 2016[2]. In the framework for fighting against climate change, countries develop their own green policies. To implement the implementing a long-term green economy regulatory framework and green policies, governments have an important role (Pahle et al., 2016). As part of the plan, they develop strategies for increasing the share of green investments. Government support to green investment is essential. According to Eyraud et al. (2013), primary goals of the support schemes should be: (a) reduction in carbon emissions and fighting climate change, (b) sustaining and advancement of energy security by varying the energy mix, and (c) stimulation of economic growth by promoting competitiveness, creating employment opportunities and innovation in new industries.

There are many definitions for green investment, and definitions can vary from sector to sector. The alternative terms such as “clean”, “sustainable” and “climate change” investment are used interchangeably in literature to indicate green investments (Inderst et al., 2012). In this literature review, we use definition of green investments proposed by Eyraud et al. (2013) as “*the investment necessary to reduce greenhouse gas and air pollutant emissions, without significantly reducing the production and consumption of non-energy goods*” (page 853). Greenhouse gases are mainly carbon dioxide, whereas air pollutants are sulphur dioxide and nitrogen oxide.

Theoretical determinants of investments are already well-established: interest rates, income level and growth, and production costs. However, green capital accumulation may include different and specific determinants. For example, by using data on renewable green investment from Bloomberg New Energy Finance, Eyraud et al. (2013) has empirically investigated determinants of the green investment. These macroeconomic factors are economic growth, a sound financial system conducive to low interest rates, and high fuel prices. By using large panel of data of 123 developed and developing countries between years 2000–2017, Tawiah et al. (2021) have investigated determinants of green growth. According to their findings, economic development has a positive impact on green growth. In addition,

[2] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

high energy consumption reduces the green growth while renewable energy consumption increases the green growth.

In addition to determinants of green investments, one may indicate government interventions (including support plans) as one of the important push factors which may help to boost green investment. Some studies have strong empirical evidence to show the importance of this factor. For example, by employing patent application data for four western European countries, Denmark, Germany, Spain, and Sweden, over the period 1977–2009, Lindman and Söderholm (2016) has investigated the effects of public R&D support and feed-in tariff schemes on innovation in the wind energy sector[3]. Their results demonstrate that both public R&D support and feed-in tariffs have positively impacted patent application counts in the wind power sector. Likewise, Eyraud et al. (2013) made econometric estimations for understanding the role of public interventions in green investment. Their results put forward that feed-in-tariffs and carbon pricing mechanisms are likely to support green investment. Karásek and Pavlica (2016) have studied green investment schemes in the Czechia. They exploited the database of the Information System of the Green Savings Programme by the State Environmental Fund of the Czech Republic and they selected abatement costs and greening ratio indicators as the evaluation parameters. Their results reveal that support measures show high effectiveness in reducing emissions.

1.2. Green investments and the macroeconomy. Brief country cases

UNEP (2011) defines a green economy as "*one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*". To build green economy via green investments, many different socio-economic indicators alongside environmental indicators needed to be assess with care. Previous studies have investigated the links between green policies (to achieve green investments) and macroeconomic indicators, such as economic growth, employment. Various green policies in different countries will be briefly presented in this subsection.

Energy efficiency is also important component of green energy economy. Hence investments for improving energy efficiency could be also considered as green investment. Accordingly, this may eventually lead to positive changes in GDP and employment. Several papers have investigated the link between energy efficiency programs and economic indicators in different locations (see e.g. Scott et al., 2008; Frondel et al., 2010; Tourkolias and Mirasgedis, 2011; Yi, 2013). This possible association is empirically investigated for several countries. Summarized version of results are presented in Table 1.

[3] "*A feed-in tariff (FIT) is an energy supply policy focused on supporting the development of new renewable energy projects by offering long-term purchase agreements for the sale of RE electricity*" (Cory et al., 2008, page 6)

By using an input–output model, which is created based on the Swiss economy, program administrator data, Swiss, and European statistics, Yushchenko and Patel (2016) estimated consequences on GDP and employment of energy efficiency programs in Switzerland. Their results have demonstrated the positive repercussions of energy efficiency programs on GDP and employment. More specifically, each Swiss Franc (CHF) spent within the energy efficiency program increases Swiss GDP by around 0.2 CHF compared to the reference case scenario. Its employment contribution is also quite significant. 1 million CHF spending in Eco-sociales and Communs d'immeubles would increase employment with approximately 0.7 and 1.6 additional jobs in full-time, respectively.[4]

Another recent study by Keček et al. (2019) have investigated the economic consequences of renewable energy sources (RES) investments in the Croatia by utilizing input-output methodology. They used varieties of renewable energy sources in their analysis such as wind power plants, solar energy, biomass, biogas, small scale hydropower plants. According to their results, the largest effects on the Gross Value Added (GVA) of 674 thousand EUR have been achieved by biogas-operated power plants (in terms of total effects induced by 1 million EUR of RES investments). The effect of this type of investment is two times larger than wind power plants. Furthermore, their total multipliers indicate that per 1 million EUR of GVA realized by the domestic supplier of equipment, additional 1.6-1.8 Eur of GVA generated in overall Croatian economy. 1.2–1.8 full time jobs are induced in units included in the value-added chain for each 1 direct job.

Also by employing input-output tables, Markaki et al. (2013) have studied the effect of clean energy investments on Greek economy between 2010-2020 years. According to the paper, they expected total green investments to reach to 47.9 bn Euro. The impact of this investment on annual increase of national product has been calculated to be ranging from 8.3 bn Euro to 11.3 bn Euro which corresponds to 3.8–5.0% of the country's GDP and estimated to generate 108,000 (92,300 to 135,200) full-time jobs within the period of 10 years.

Behrens et al. (2016) performed a hybrid input–output analysis of historic feed-in tariff impacts on Portuguese economy between 2000-2010. They divided effects into three categories: environmental, economic and social. According to their findings, the combined historical renewable energy policy (primary energy policy is feed-in tariff) and renewable energy developments resulted a salient decrease in emissions, 7.2 MtCO2eq, a rise in GDP of 1557 M€, and a creation of 160 thousand job-years. Employment numbers can be converted in comparable terms, which is a job ratio over the 2000–2010 period of 1.15 jobs/MW. Finally, employment results, hence, are comparable with the other from different locations such as range of 0.76 to 6.97 jobs/MW for different EU countries (Blanco and Rodrigues, 2009).

[4] Eco-sociales focuses on social housing while Communs d'immeubles is related to common spaces in buildings.

Study by Madlener and Koller (2007) have examined the economic and environmental effect of bioenergy promotion in the Austrian federal province of Vorarlberg. Their results have shown that significant economic consequences of the bioenergy investments are realized. More specifically, total investment in biomass district heating (BDH) systems has induced an estimated gross domestic value-added domestic effect of 92.9 million EUR, an employment effect of 1,580 person-years, and fiscal effects of 23.3 million EUR. Furthermore, per million euros of subsidy granted by the Land Vorarlberg generated a domestic value-added of 5.6 million EUR a fiscal effect of 1.4 million EUR and created 91 jobs-year.

Table 1. Summarized details of green investment effects on economic indicators across different countries

Study	Scope	Object	Outcome
Madlener and Koller (2007)	Austrian federal province of Vorarlberg	Biomass district heating (BDH) systems	Gross domestic value-added domestic effect of 92.9 million EUR, an employment effect of 1,580 person-years, and fiscal effects of 23.3 million EUR
Markaki et al. (2013)	Greece	Various green investments	Increase of national product 8.3 bn Euro to 11.3 bn Euro which corresponds to 3.8–5.0% of the country's GDP and estimated to generate 108,000 (92,300 to 135,200) full-time jobs.
Yushchenko and Patel (2016)	Switzerland	Energy efficiency programs	Each Swiss Franc (CHF) spent within the energy efficiency program increases Swiss GDP by around 0.2 CHF. 1 million CHF spending in programs would increase employment by 0.7 – 1.6 additional jobs in full-time.
Behrens et al (2016)	Portugal	Feed in tariff	Reduction in emission by 7.2 MtCO2eq, a rise in GDP of 1557 M€, and a creation of 160 thousand job-years (1.15 jobs/MW).
Keček et al. (2019)	Croatia	Renewable energy sources investments	Per 1 million EUR of gross value added (GVA) realized by the domestic supplier of equipment, additional 1.6-1.8 Eur of GVA generated in overall Croatian economy. 1.2–1.8 full time jobs are induced in units included in the value-added chain for each 1 direct job.

Lyeonov et al. (2019)	EU countries	green investments	Increase the economic growth by 6.4%, reduction in greenhouse gas emissions by 3.08%

By employing a novel 'Sectoral Energy-Economic Econometric Model', Blazejczak et al. (2014) examined the net balance of economic effects associated with renewable energy deployment in Germany until 2030. Their findings show that the expansion of renewable energy in Germany has a positive net impact on economic growth and employment. A primary reason for the result is increased investment activity.

Lyeonov et al. (2019) investigated the link between green investments and sustainable development using various econometric modelling and data on EU member states. Their results demonstrate that green investments could increase the economic growth by 6.4%, may reduce greenhouse gas emissions by 3.08%, could the increase of renewable energy in the total final energy consumption by 5.6%.

Chien and Hu (2007) employed the DEA method to predict the technical efficiency (TE) for the 45 economies from 2001 and 2002. According to their findings, renewable energy has a positive effect on GDP via increasing the capital formation. Hence, this result suggest that governments are advised to implement the renewable energy policy by providing tax incentives for the establishment of renewable industries as an efficient tool (Chien and Hu, 2007).

1.3. Green investment and employment

Another important macroeconomic indicator is employment which is directly related to human well-being and welfare of society. Past studies have shown evidence that green investment is related to higher employment levels. However, before discussing literature on the relationship between green investments and employment, it is important to discuss green jobs. Although no standard definition of a "green job" is present (Morris et al., 2009), green jobs could be considered as jobs primarily related to the environmental objectives and policies (Bowen and Kuralbayeva, 2015). OECD and Eurostat definition of environmental goods and services industry (OECD, 1999): "*activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products and services that reduce environmental risk and minimize pollution and resources*." Alternatively, European Commission (2012, p. 4) defines green jobs as "*jobs that depend on the environment or are created, substituted or redefined (in terms of skill sets, work methods, profiles greened,*

etc.) in the transition process towards a greener economy"[5] Hence, one may claim that the employment related to the environmental goods and service industry could be called green jobs.

According to the report from OECD (2017), green policies may influence to labour market in multiple ways as transition of economy from environmentally damaging to less polluting and more resource efficient economic model is expected to change structures of production and market. First, employment creations in 'green' sectors which produce goods and services that diminish environmental pressure. Second, jobs get lost in the 'brown 'sectors which have damaging environmental footprints and these sectors get replaced by the green activities. Third, as a result of employment creation and destruction, it is likely to be observed a net employment gain which are induced by changed in relative prices driving shift in the structure of the economy towards environmentally friendly and cleaner production sectors which are rather labour intensive service sectors. Finally, yet importantly, if ambitious strategies slow down economic growth, there could be a potentially a net job loss. In all these mechanism, temporary effects would be primarily driven by transition to green growth, whereas permanent part is would be result of green economy.

Studies tend to use various measurements for evaluating the job creation potential of renewable energy technologies industry to the economy. For example, Dalton and Lewis (2011) found that the use of jobs/megawatt installed in one year is an unreliable metric, because ratios are sensitive to installed megawatt (MW) in the year of the study. In contrast to the jobs/megawatt measure, Dalton and Lewis (2011) recommended jobs/cumulative MW, jobs/1000 head of population or MW/million head of population may be a more reliable metric. Use of EU job/MW is also found unreliable by Blanco and Rodrigues (2009) since due to differences in export/import capacity. For assessing job creation, policy makers may be interested in costs rather than job created per megawatt. This point was raised in study of Lambert and Silva (2012) and offered that jobs created per dollar invested in green energy would be complimentary next to jobs created per megawatt. However, these discussions would eventually lead to the use of more standardized measures globally for assessing the actual potential of renewable energy technology in job creation.

Literature has not yet reached to agreement about employment creation effects of green investment policies whether these increases total rate of employment or not. It is important to note that in analysis of such effects, one group of studies tend to rely on only jobs directly created or destroyed by the policies ('direct' employment effects), whereas other add up jobs created or destroyed within the supply chain for the products and services supported by green policies ('indirect' employment effects) (Bowen and Kuralbayeva, 2015). In this context, mostly used method is the use of Input-Output tables to analyse both direct and indirect

[5] European Commission (2012). Exploiting the employment potential of green growth. SWD (2012) 92 final, Brussels; 2012.

employment effects. Some studies also consider the assessment of induced effects that are related to the expansion of private expenditures on goods and services (Lambert and Silva, 2012). This would enable to calculate jobs created as a result of green policies in sectors where there is no apparent link to environmental objectives (Bowen and Kuralbayeva, 2015).

Wei et al. (2010) put forward crucial points for the employment effects of green investment by reviewing 15 studies on the job creation potential of renewable energy, energy efficiency, and low carbon sources and nuclear power. According to their findings, renewable energy sector create more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment, than the fossil fuel-based energy sector.

As part of the green investment, transition to cleaner energy sector will require mobility of labour from fossil fuel industries. It implies that there could job creation through green investment in green sectors and job destruction in brown sectors. For example by using the employment factor approach and general equilibrium analysis, Fragkos and Paroussos (2018) have studied the net employment effects from the projected transformation of the European Union energy industry towards Renewable Energy Sources (RES). Compared to fossil fuel sector, renewable energy technologies are likely to be more labour intensive. According to findings of Fragkos and Paroussos (2018) RES expansion in the European Commission Clean Energy Package context could lead to a remarkable grow in direct green jobs to 850,000 in 2030 and to approximately 1.85 million jobs in 2050 representing about 1% of the EU labour force. These jobs are expected to be provided in the construction of solar photovoltaics, the supply and production of advanced biofuels and in the manufacturing and installation of wind turbines.

When assessing the employment effects of green investment, it is important to take into account different time horizons. Fankhaeser et al. (2008) divided time horizons into three: short, medium and long term effects of green investment. The short term effect can be attributed to the direct employment effect which implies that jobs are created in green sectors (for example, wind energy sector) while jobs are destroyed in brown sectors (for example, fossil fuel industries) as a result of policies. Since as low-carbon technologies are likely to be more labour-intensive and efficiency gains may exceed costs, one may observe net job creation in the short term. The medium term effect can encompass indirect and induced effects and may occur when climate change policy diffuses its effect througout economy by offering new employment opportunities and reducing jobs in value chains of related industries. However, it is not easy to gauge this effect since there could be other factors such as trade effects. Sizewise largest effect may take place in the long term. As climate policy could initiate structural changes in whole economy, and society, creative destruction can be seen through technological development. Technological development and innovation related to green investment may lead to green growth and job creation in long term.

1.4. Transition to green growth

Green investment may require different skill sets, qualifications compared to brown sectors. For example, Blanco and Rodrigues (2009) have emphasised the scarcity of certain jobs such as project managers, engineers, and O&M technician in European Union's wind energy sector. Hence, vocational education, training and mobility should receive an attention. Even further transformation of jobs would be needed to adapt workers to new sectors.

As mentioned above, Blazejczak et al. (2014) have found positive impact of the expansion of renewable energy on employment in Germany. But this positive effect is conditional on labour market conditions which is more flexible labour market conditions lead to remarkable job creation. Therefore, this flexible labour market condition would enable to provide smooth transition of labour across sectors. Otherwise, transition would cause to long period of unemployment while changing jobs and shifting to green sectors from brown sectors.

Despite some empirical works found positive relationship between green investment and job creation, there could be unexpected predicaments during the process of job creation. In this context, Cai et al. (2014) have studied renewable and new energy development's distributional employment effects on gender and personnel structure by using Chinese Input-Output data. Their findings suggest that development of renewable and new energy may worsen the gender inequality problem and add to the level of mismatch between the structure of labor demand and supply. Quantitatively speaking, they found that around 18% of estimated 7.16 million jobs created by the development of renewable and new energy between years 2011 and 2020 cannot be realized. These results urge policymakers to not only focus on numbers, but also socio-economic repercussions and conditions of transformation toward green economy. More specifically, it is crucial to provide equal promotion possibilities for women, courses, and trainings to renewable energy related majors, for purpose of eliminating the structural unemployment problem and accelerate green transition process.

1.5. Economic crisis and green investment: the case of COVID

Several international organizations indicate the importance of turning to green economy during the process of recovering from COVID-19. International Labor Organization Director-General Guy Ryder has made this statement at the UN High Level Political Forum event on the Green Economy and COVID19 recovery: "*we must address now the existential challenges of climate change and environmental sustainability*" (ILO, 2020). Similarly, OECD published policy briefs which aims to elaborate ways on how countries can generate possibilities for a green and inclusive economic recovery from the COVID-19 pandemic (OECD, 2020). Indeed, COVID-19 has given lesson that pollution and GDP are still linked, thus, policies should aim at mitigating climate change and biodiversity loss (Helm, 2020).

Some scholars have shown evidence that COVID-19 could be good for environment. For example, Oncioiu et al. (2021) have estimated the effect of the two economic shocks (economic shocks of supply and demand) generated by the COVID-19 crisis on the climate sphere at the level of the Member States of the European Union. Their results demonstrated that both economic shocks had the effect of decreasing the level of greenhouse gases, causing to a positive effect on the environment. Their findings therefore suggested that these kinds of shocks may persuade society to rethink about link between environmental policies and economy and would be considered as an opportunity to put emphasis on and embrace to the green economy.

As mentioned in previous sections, green transition would lead elimination of brown sectors and job destructions were inevitable in those sectors. However, COVID-19 pandemic has already led to termination of several businesses including ones in brown industries. These means that unemployment level increased, and the unemployed people should be allocated to new jobs. Furthermore, governments can provide support to communities affected adversely from this crisis in their transition to low-carbon sectors by retraining, reskilling, facilitating their mobility (OECD, 2020). In addition, governments may use this chance to encourage establishing green sectors, hence, employing these unemployed people in new low carbon sectors. Previous experiences also provide factual evidence that even crisis times, green sectors might still maintain job creation. For example, during recession times, the solar energies industry has managed to create over 100,000 jobs in 2009 in EU-27, photovoltaic sectors and solar thermal created 121,800 and 48,970 in 2009, respectively. (Çetin and Eğrican, 2011). Therefore, governments may turn this crisis into opportunity for developing green economy.

1.6. References

Behrens, P., Rodrigues, J. F., Brás, T., and Silva, C. (2016). Environmental, economic, and social impacts of feed-in tariffs: A Portuguese perspective 2000–2010. Applied energy, 173, 309-319.

Blanco, M. I., and Rodrigues, G. (2009). Direct employment in the wind energy sector: An EU study. *Energy policy*, *37*(8), 2847-2857.

Blazejczak, J., Braun, F. G., Edler, D., and Schill, W. P. (2014). Economic effects of renewable energy expansion: A model-based analysis for Germany. *Renewable and sustainable energy reviews*, *40*, 1070-1080.

Bowen, A., and Kuralbayeva, K. (2015). Looking for green jobs: the impact of green growth on employment. *Grantham Research Institute Working Policy Report. London: London School of Economics and Political Science*.

Cai, W., Mu, Y., Wang, C., and Chen, J. (2014). Distributional employment impacts of renewable and new energy–A case study of China. Renewable and Sustainable Energy Reviews, 39, 1155- 1163

Çetin, M., and Eğrican, N. (2011). Employment impacts of solar energy in Turkey. *Energy Policy*, *39*(11), 7184-7190.

Chien, T., and Hu, J. L. (2008). Renewable energy: An efficient mechanism to improve GDP. Energy policy, 36(8), 3045-3052.

Cory, K., Kreycik, C., and Williams, E. (2010). A policymaker's guide to feed-in tariff policy design. *US Dept. of Energy, National Renewable Energy Laboratory, Washington*.

Dalton, G. J., and Lewis, T. (2011). Metrics for measuring job creation by renewable energy technologies, using Ireland as a case study. *Renewable and Sustainable Energy Reviews*, *15*(4), 2123-2133.

Eyraud, L., Clements, B., and Wane, A. (2013). Green investment: Trends and determinants. *Energy Policy*, *60*, 852-865.

Fankhaeser, S., Sehlleier, F., and Stern, N. (2008). Climate change, innovation and jobs. *Climate policy*, *8*(4), 421-429.

Fragkos, P., and Paroussos, L. (2018). Employment creation in EU related to renewables expansion. *Applied Energy*, *230*, 935-945.

Frondel, M., Ritter, N., Schmidt, C. M., and Vance, C. (2010). Economic impacts from the promotion of renewable energy technologies: The German experience. *Energy Policy*, *38*(8), 4048-4056.

Helm, D. (2020). The environmental impacts of the coronavirus. *Environmental and Resource Economics*, *76*, 21-38.

Inderst, G., Kaminker, Ch., Stewart, F. (2012), "Defining and Measuring Green Investments: Implications for Institutional Investors" Asset Allocations", OECD Working Papers on Finance, Insurance and Private Pensions, No.24, OECD Publishing.

International Labour Organization (2020). Link: https://www.ilo.org/global/about-the-ilo/multimedia/video/institutional-videos/WCMS_751062/lang--en/index.htm Accessed: 8 April 2021

International Monetary Fund (2008), Climate Change and the Global Economy, World Economic Outlook, Washington.

Karásek, J., and Pavlica, J. (2016). Green investment scheme: Experience and results in the Czech Republic. *Energy Policy*, *90*, 121-130.

Keček, D., Mikulić, D., and Lovrinčević, Ž. (2019). Deployment of renewable energy: Economic effects on the Croatian economy. Energy policy, 126, 402-410.

Lambert, R. J., and Silva, P. P. (2012). The challenges of determining the employment effects of renewable energy. *Renewable and Sustainable Energy Reviews*, *16*(7), 4667-4674.

Lindman, Å., and Söderholm, P. (2016). Wind energy and green economy in Europe: Measuring policy-induced innovation using patent data. *Applied energy*, *179*, 1351-1359.

Lyeonov, S., Pimonenko, T., Bilan, Y., Štreimikienė, D., and Mentel, G. (2019). Assessment of green investments' impact on sustainable development: Linking gross domestic product per capita, greenhouse gas emissions and renewable energy. Energies, 12(20), 3891.

Madlener, R., and Koller, M. (2007). Economic and CO2 mitigation impacts of promoting biomass heating systems: an input–output study for Vorarlberg, Austria. Energy Policy, 35(12), 6021-6035.

Markaki, M., Belegri-Roboli, A., Michaelides, P., Mirasgedis, S., and Lalas, D. P. (2013). The impact of clean energy investments on the Greek economy: An input–output analysis (2010–2020). Energy Policy, 57, 263-275.

Morriss, A. P., Bogart, W. T., Dorchak, A., and Meiners, R. E. (2009). 7 Myths about green jobs. *U Illinois Law & Economics Research Paper No. LE09-007, Case Legal Studies Research Paper*, (09-14).

Oncioiu, I., Duca, I., Postole, M. A., Gherghina, R., and Grecu, R. A. (2021). Transforming the COVID-19 Threat into an Opportunity: The Pandemic as a Stage to the Sustainable Economy. Sustainability, 13(4), 2088.

Organisation for Economic Co-operation and Development (OECD), 1999. The environmental goods and services industry: Manual for data collection and analysis. Paris: Organisation for Economic Co-operation and Development.

Organisation for Economic Co-operation and Development (OECD), 2017. Employment Implications of Green Growth: Linking jobs, growth, and green policies. Paris: Organisation for Economic Co-operation and Development.

Organisation for Economic Co-operation and Development (OECD), 2020. Making the Green Recovery work for jobs, income and growth. Paris: Organisation for Economic Co-operation and Development.

Pahle, M., Pachauri, S., and Steinbacher, K. (2016). Can the Green Economy deliver it all? Experiences of renewable energy policies with socio-economic objectives. *Applied Energy*, *179*, 1331-1341.

Scott, M. J., Roop, J. M., Schultz, R. W., Anderson, D. M., and Cort, K. A. (2008). The impact of DOE building technology energy efficiency programs on US employment, income, and investment. *Energy Economics*, *30*(5), 2283-2301.

Tawiah, V., Zakari, A., and Adedoyin, F. F. (2021). Determinants of green growth in developed and developing countries. Environmental Science and Pollution Research, 1-16.

Tourkolias, C., and Mirasgedis, S. (2011). Quantification and monetization of employment benefits associated with renewable energy technologies in Greece. *Renewable and Sustainable Energy Reviews*, *15*(6), 2876-2886.

United Nations Environment Programme, (2011). Towards a green economy: Pathways to sustainable development and poverty eradication. *Nairobi, Kenya: UNEP*.

Wei, M., Patadia, S., and Kammen, D. M. (2010). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?. *Energy policy*, *38*(2), 919-931.

Yi, H. (2013). Clean energy policies and green jobs: An evaluation of green jobs in US metropolitan areas. *Energy policy*, *56*, 644-652.

Yushchenko, A., and Patel, M. K. (2016). Contributing to a green energy economy? A macroeconomic analysis of an energy efficiency program operated by a Swiss utility. *Applied Energy*, *179*, 1304-1320.

2. Health care expenditures

2.1. Health care expenditures and health outcomes

The major challenge faced in the modelling of the relationship between health care spending and economic growth is the problem of causality which poses a question of does health causes economic growth or vice versa (Swift, 2011; Ameria and Ventelou, 2012). In the same vein, research outcomes have shown different and contradictory outcomes in ascertaining the relationship between health care expenditures and health outcomes (Heuvel and Olaroiu, 2017), so the literature cover various approaches adopted to mitigate this challenge.

Several measures have been adopted to measure health outcomes ranging form life expectancy, maternal mortality, self-reported health, infant mortality and disease level perspective (Afonso and St Aubyn, 2005; Retzlaff-Roberts, Chang, and Rubin, 2004; Heijink, Koolman and Westert, 2013). Also, several studies have been carried out to explore the causal relationship between health spending on health outcomes, despite the increase study, contradictory findings have been put forward (Farag et. al. 2013; Rad et al. 2013; Karaman et. al. 2020). Using a disease level perspective health measure (avoidable mortality, defined as death form certain conditions that should not have occurred given a timely and effective health care system) Heijink, Koolman and Westert (2013) contributed to the literature on health care spending and health outcomes by embarking on a study of 14 western countries between 1996 and 2006. The study adopted descriptive statistics and multiple regression models considering variations within country and growth rates. The study suggests that for all countries considered in the study there existed an increase in health care expenditures which was also accompanied by a decrease in avoidable mortality.

Using data from 30 OECD countries, Karaman et. al. (2020) observed that the variables of interest show different result from one country to another, this was attributed to the methodology and or the data type available. In similar manner with other studies, maternal and infant mortality reduces with an increase government spending per capita. Similarly, male and female life expectancy at birth and male and female life expectancy at 80 increased with increase in government expenditures on health care per capita which as reported by previous studies.

Between the year 1960 and 1995, countries in the European Union experienced a fall in the average infant mortality rate from 3.3 percent to 0.6 percent per 1000 live birth. In the same year average life expectancy at birth for females rose from 72.5 to 80 years and male life expectance of male at birth rose from 67.6 to 73.6 years. All these improvements in health outcome correspond to a period when total health expenditures as a percentage of GDP in the EU experienced an increase; precisely from 3.4 percent to 7.7 percent (Nixon and Ulmann, 2006; OECD, 2000). Nixon and Ulmann (2006) adopting an econometric approach explored the causal effect of public spending on health outcome. Their study uses life expectancy at

birth for men and women, and infant mortality as dependent variables to measure health outcome for 15 EU countries covering a period between 1980 and 1995. They conclude that health care expenditures have a relatively weak or small impact on life expectancy but has a significant impact in reducing infant mortality (Mckeown, 1979).

Classifying Central and Eastern Europe countries (CEE) based on socio economic transformation and health sector into EU accession members as of 2004 (EU 2004), South-Eastern European (SEE) and Commonwealth of Independent States (CIS), Jakovljevic et al. (2015) see that having experienced substantial increase in health expenditures, the effect in health outcomes were not similar across the countries. In almost all EU 2004 countries, with the highest health expenditure growth there was a substantial increase in longevity as well as in the SEE countries. Contrary the CIS countries exhibited a slight increase or even a decline in longevity.

An important factor to consider in determining the efficacy of health expenditures on health outcomes is the quality of the health spending (Deshpande, et al., 2014) to further reinforce this assertion Heuvel and Olaroiu (2017) find that the role attributed to social protection in the determinant of life expectancy at birth is more pronounced than the role attached to health care expenditures in Europe. Another interesting study with a similar conclusion is by Bradley et al. (2016), that studies fifty states of the US between the period of 2000 and 2009. Health care spending was divided into the spending on social determinants of health such as housing, nutrition, support categorized as spending on social services and public health relative to spending on the medical determinant of health. According to their study, adequate investment in the social determinants of health as compared to a one-way investment in health care shows a positive relationship with health outcomes and can also paly an important role in explainaing the variation in health outcome across different states or region.

Blazquez-Fernandez, Centarero-Prieto and Pascual-Saez (2017) in their study suggests a bit different results from most of the other studies. Their study adopted a multiple linear regression technique to explore the relationship between health expenditures and socio-economic determinants of life expectancy in 8 OECD Asia/Pacific area countries. In the USA, health expenditures show a negative relationship with health outcome, whereas in the other 7 countries health expenditures exhibits a positive relationship with life expectancy. The finding of negative relationship between health expenditures and health outcome in the USA can be because of poor performance in government health expenditure. Thus, the performance of health expenditures is just as important as the expenditures itself in the objective of the government to achieve economic goals. For an overview of papers relating health care expenditures and health outcomes, see Table 2.

Table 2. Summary of Health Care Expenditures and Health Outcomes

Author	Scope	Methodology	Variables	Findings
Heijink, et al. (2013)	14 western countries between 1996 and 2006	Descriptive analysis and multiple regression	**Outcome variable**: Avoidable mortality rate. **Explanatory variables**: Health care spending, education, unemployment rate, alcohol consumption.	Countries with above average spending health care spending shows an above average reduction in avoidable mortality.
Karaman et al. (2020)	30 OECD countries	Stepwise multiple regression analysis	**Outcome variable**: Infant and maternal mortality, male and female life expectancy at birth and in 80 years, self-reported health. **Explanatory variables:** Health care spending as a share of GDP, Public and private healthcare spending per capita, pharmaceutical spending per capita.	Public health care spending per capita has a significant negative impact on maternal and infant mortality, male and female life expectancy at birth and in 80 years whereas private health care spending was found to have a significant positive impact on self-reported health.
Nixon and Ulmann (2006)	15 former members of the European Union between 1980 and 1995	Fixed effect model	**Outcome variable**: Male and female life expectancy, infant mortality. **Explanatory variables:** Total per capita health expenditure, health expenditures as a proportion of GDP, number of physicians (per 100 head of population), number of hospital beds (per 100 head of population), nutrition.	Health expenditures contribute positively to male life expectancy as well as female life expectancy. Health expenditures impact negatively the infant mortality.
Jakovljevic, et al. (2016)	24 countries between the period of	Difference-in-Difference, Data Envelopment analysis	**Outcome variable:** Life expectancy at birth. **Explanatory variables:** Health expenditure.	As compared to CIS and SSE, EU2004 countries have the strongest growth in expenditures which leads to a longevity increase in EU 2004

	1989 and 2012			countries and surprisingly in SEE countries.
Blazquez-Fernan-dez, et al. (2017)	8 OECD Asia /Pacific area between 1995 and 2013	Multiple Regression	**Outcome variable:** Life expectancy at birth. **Explanatory variables:** Health expenditures per capita, GDP per capita, unemployment, exchange rate.	For the full sample and the United State health care expenditures have a negative effect on health whereas all other countries exhibit a positive relationship between health care expenditures and health.
Bradley et al. (2016)	Fifty USA states and the district of Columbia between the period of 2000 and 2009	Descriptive statistics, Linear Regression	**Outcome variable:** adult obesity, asthma, mentally unhealthy days, days with activity limitation, mortality rate from lungs cancer, acute myocardial infraction and type 2 diabetics. **Explanatory variables:** Spending on social service and public health relative to spending on health care in the state, nutrition, housing,	States with higher ratio of social to health spending were reported to have a significantly better health outcome.
Van den Heuvel and Olaroiu (2017)	31 European countries	Correlation and Forward Linear Regression Analysis	**Outcome variable:** Life expectancy at birth. **Explanatory variables:** Health care expenditures, expenditures on education and on social production.	Health care expenditures are not the main determinant of life expectancy at birth but social protection expenditure. Thus, increasing expenditures on social protection at the expense of health care causes better health.

2.2. Health care expenditures and economic growth

A production function puts forward that output is a function of labour and capital. Labour can be viewed as a form of human asset which plays an integral part in the production process. Improved health of humans contributes positively to the labour assets of human which in turn increase productivity and output in the economy.

An all-time relevant debate among researchers have been weather government health expenditures cause economic growth or vice versa. Different methods have been adopted by researchers which have also influenced the nature their result and conclusion reached. Papers find that in some countries government health spending has been seen to granger cause economic growth and in some other countries there exist no relationship between economic growth and government health expenditure. Thus, we can view the relationship between health care expenditure and economic growth to be an inverted U-shaped curve. Such that countries that are below maximum point exhibit a positive relationship between health spending and economic growth whereas countries above the maximum point exhibit a negative relationship between government health spending and economic growth.

Various methodologies have been adopted to study the effect of health expenditures on economic growth, from less complicated methodologies such as descriptive statistics and Ordinary Least Squares regression (OLS) to complicated methodologies such as VAR, VECM, ARDL and Computable General Equilibrium CGE (Dincer and Yuksel, 2019). Methodologies adopted by various studies is determined by the nature and accessibility of data, aim of the research, scope of the study and model restrictions.

Starting form the general equilibrium perspective, viewing the economy wholly against segmented parts, Campodonico et al. (2014) explore the effect of government spending on health, education and infrastructure on the economic growth of Peru. The study calibrated five scenarios of which three were related to public expenditure. First scenario is a combination of 2.5 percent increase in expenditures on infrastructure, 1.25 percent increase in expenditures on education and 1.25 percent increase in expenditures on health result in a positive impact on GDP. Second scenario was calibrated to be a 2.5 percent increase in government expenditures on health, 2.5 percent increase in expenditures on education and decreasing expenditures to infrastructure by 5 percent, resulted in a small however positive effect on GDP as compared to the base scenario. The third scenario was calibrated to be a 5 percent increase in government spending on infrastructure and 2.5 percent decrease in both health and education spending respectively which resulted in a negative impact on GDP as compared to the base line scenario. The study concludes that in the long run it is of benefit to government spending on education and health over infrastructure, as this generated more economic growth, reduced unemployment, poverty and inequality.

To accommodate differences in income level among countries Wang (2011) adopted a quintile panel-type regression in addition to a panel regression analysis to investigate health care expenditures and economic growth data for 31 OECD countries between a period of 1987 and 2007. The result of the panel data regression (VECM) suggests that there exists a bi-directional relationship between GDP and health expenditure. In a more precise manner, an increase in health expenditure growth will lead to an increase in economic growth. However, an increase in economic growth will lead to a reduction in growth of health care expenditures. In similar manner to the panel regression the quintile regression suggests that changes in health

expenditures have a significant influence on economic growth however with different signs based on economy's income quantile. For economies in the lowest 0.05th income quantile, growth of government health expenditures influences negatively economic growth while growth in the health expenditures influences positively economic growth for all other quantiles.

Considering testing health care expenditures led economic growth in OECD countries Artekin and Konya (2020) adopted a panel data analysis on data between year 1980 and 2017 for 19 OECD countries. Their study finds that in the long run health expenditures have a positive impact in economic growth, through increase in the societal human capital. In a similar manner. Swift (2011) adopted a Johansen multivariate cointegration technique to examine if there exist a long or short run relationship between health and economic growth. In the long run the study reported that there exist a positive and significant relationship between health and economic growth for eleven OECD countries except for Finland and Spain. The study supports the hypothesis of health led growth, in the same vein Atilgan, Kilic, Ertugrul (2016) found the same for Turkey.

Adopting a robust methodology Ye and Zhang (2018) studied the healthcare expenditures and economic growth using a Nonlinear Granger Causality. This approach gives more information as it provides answers to questions such as does health expenditures granger cause economics growth or vice versa? The study used data for 15 OECD countries and 5 developing economies and finds that for Ireland, Portugal, US, China and India a unidirectional linear granger causality running from per capita GDP to per capita health expenditure. For countries such as Belgium, Norway and Mexico, a unidirectional linear causality also exists however running form per capital health care expenditures to per capita GDP. In contrast, a bidirectional linear causal relationship was found in Canada, Finland, Iceland, New Zealand, Spain, Brazil and South Africa. On The other hand, no linear causality was found for Australia, Austria, Japan and UK. For Finland New Zealand, Japan, Portugal, US and China a nonlinear Granger causality was found running form per capital health care expenditures to per capita GDP. The study further finds evidence that for Australia Austria, UK, Korea, Portugal and India health care expenditure cannot enhance economic growth. In the same vein, Bedir (2016) also finds that there exists a bidirectional relationship between economic growth and health expenditures where health expenditures cause economic growth and economic growth causes health expenditure.

Research have also been carried out to ascertain the horizon of an economy whereby the spending of on health has positive impact on the health outcome and invariable on economic growth of the economy among the studies are (Preston, 1975; Deaton, 2003; Wang, 2015). It has been revealed that there exists an optimal level of health expenditures to GDP rate, that beyond which contributes negatively to human capital and thus economic growth. Adopting OECD countries, Wang (2015) estimated an optimal level of health expenditures as a percentage of GDP to guarantee economic growth. A 7.5 percent health expenditures to GDP

level was reported as the optimal, below which health expenditures contribute positively to economic growth and above which contributes negatively to economic growth.

In developed economies, for health care expenditures of the government to have a positive effect on economic growth several policies and factors must be put in place. Dormont, Martins, Pelgrin and Suhrcke (2008) suggest that one possible reason for the absence of the positive relationship between health expenditures and economic growth could be the fixed and too low retirement age which prevents elderly participation in labour market. Thus, even when the health spending improves economy wide health status people move out of potential labour stream at an early and fixed age which put a negative pressure on productivity and economic growth. This problem is more present in Europe than in the US.

The outbreak of COVID-19 has engendered researchers to explore other measures of government health spending. Considering this, research has been carried out to explore health expenditures and pandemic preparedness knowing fully well that an efficient pandemic preparedness will positively bring about economic growth during pandemic outbreaks such as COVID-19. Eissa (2020) claim that pre-Covid 19, there had been a huge gap in knowledge about government pandemic preparedness among researchers also global government have neglected the area of pandemic preparedness in policy making and resource allocation. It is also important to mention that public health expenditure, increased pandemic preparedness, resilient healthcare system are important ingredients that must be present for any economy to come out strong of the COVID-19 fuelled recession and beyond. For an overview of the papers relating health care expenditures and economic growth, please see Table 3.

Table 3. A Summary of Health Care Expenditures and Economic Growth

Author	Scope	Methodology	Variables	Findings
Campodonico, et al. (2014)	Peru	Dynamic Computable General Equilibrium (DCGEM)	**Outcome variable**: GDP growth, unemployment and poverty. **Shock variables:** Infrastructure expenditure, education expenditures and health expenditure.	Increasing public investment in health and education at the expense of infrastructure has a small but positive impact on GDP.
Wang (2015)	OECD countries between the period of	Generalized Method of Moments (GMM)	**Outcome variable:** Per capita real GDP growth. **Explanatory variables:** Health expenditures to GDP ratio, square of	There exist and optimal level of health care expenditures below which an increase in health care spending leads to economic growth and above which

	1990 and 2009		health expenditures to GDP, socio-economic and demographic variables.	leads to reduction in economic growth.
Artekin and Konya (2020)	19 OECD countries between 1980 and 2017	Panel Regression – Fixed Effect Model	**Outcome variable:** GDP growth. **Explanatory variables:** Health expenditure, Life expectancy, infant mortality rate, population growth.	There exists a long-term relationship between health expenditures and economic growth, the hypothesis of health-led economic growth was found.
Ye and Zhang (2018)	15 OECD countries between 1971 and 2015, China between 1978 and 2015 and 4 major countries between 1995 and 2015	Linear Granger Causality Test, Non-linear Granger Causality Test	**Outcome variable:** Per capita GDP growth. **Explanatory variables:** Per capita health care expenditure.	In Ireland, Korea, Portugal, US, China and India economic growth leads to increase in health care expenditures. However, Belgium, Norway, and Mexico exhibit a unidirectional causality running form per capital health care expenditures to per capita output. Canada, Finland, Iceland, New Zealand, Spain, Brazil and South Africa show a bidirectional relationship whereas in Australia, Austria, Japan and UK show no linear causality between per capita health care expenditures and per capita GDP.
Atilgan, Kilic, and Ertugrul (2016)	Turkey between 1975 and 2013	Auto Regressive Distributive Lag Approach (ARDL) and Kalman Filter	**Outcome variable:** Per capita GDP growth. **Explanatory variables:** Health expenditures per capita.	A one percent increase in per capita health expenditures lead to an 0.043 percent increase in per capita GDP.

2.3. References

Afonso, A., St Aubyn, M.: Non-parametric approaches to education and health efficiency in OECD countries. *J. Appl. Econ*. 8(2), 227–246 (2005)

Amiri, A. and Ventelou, B. (2012) Granger Causality Between Total Expenditure on Health and GDP in OECD: Evidence from The Toda—Yamamoto Approach. *Econ. Lett. 116*, 541–544.

Artekin, A.O and Konya, S. (2020). Health Expenditure and Economic Growth: Is the Health Led Growth Hypothesis Supported for Selected OECD countries? *Polslovna Izvrsnost Zagreb*

Atilgan, E. Kilic, D. and Ertugrul (2017). The Dynamic Relationship Between Health Expenditure and Economic Growth: Is the Health-led Growth Hypothesis Valid for Turkey. *Eur J. Health Econ.* 18: 567-574

Bedir, S. (2016). Healthcare Expenditure and Economic Growth in Developing Countries. *Adv. Econ. Bus. 4*, 76–86

Bradley, E. H., Canavan, M., Rogan, E., Talbert-Slagle, K., Ndumele, C., Taylor, L. and Curry, L. A. (2016). Variation in Health Outcomes: The Role of Spending on Social Services, Public Health and Health Care. *Health Affairs,* 35. 760-768

Blazquez-Fernandez, C., Centarero-Prieto, D. and Pascual-Saez, M. (2017). Health Expenditure and Socio-economic Determinants of Life Expectancy in the OECD Asia/Pacific Area Countries. *Applied Econometrics Letters* 24(3) 167=169

Campodonico, B. J. F., Cassinelli, J. R. P and Mesones, J. A. (2014). The Impact of Public Expenditure in Education, Health and Infrastructure on Economic Growth and Income Distribution in Peru. IDB Working Paper Series No. IDB-WP-490.

Deshpande N, Kumar A, Ramaswami R. (2014). The Effect of National Healthcare Expenditure on Life Expectancy. World Bank Report Washington, D.C.: World Bank.

Deaton A. (2003). Health, Inequality and Economic Development. *J Econ Lit*.41(1):113-158.

Dincer, H. and Yuksel, S. (2019). Identifying the Causality Relationship between Health Expenditure and Economic Growth: An Application on E7 Countries. *Journal of Health Systems and Policies 1*

Dormont, B., Martins, J.O., Pelgrin, F. and Suhrcke, M. (2008). Health Expenditure, Longevity and Growth. Paper Presented at IX Annual Conference of the Fondazione Rodolfo de Benedetti.

Eissa, N. (2020). Pandemic Preparedness and Public Health Expenditure. *Economics* 8 (60)

Farag, M., Nandakumar, A. K., Wallack, S., Hodgkin, D., Gaumer, G., and Erbil, C. (2013) Health Expenditures, Health Outcomes and the Role of Good Governance. *Int J Health Care Finance Econ*; 13(1): 33–52

Van den Heuvel, W. J. A and Olaroiu, M. (2017). How Important Are Health Care Expenditure for Life Expectancy? A Comparative, European Analysis. *JAMDA 18.* 9-12

Heijink, R., Koolman, X. and Westert, G.P. (2013). Spending More Money, Saving More Lives? The Relationship Between Avoidable Mortality and Healthcare Spending in 14 Countries. *Eur J Health Econ* 14:527-538

Jakovljevic, M. B., Vukovic, M. and Fontanesi, J. (2015). Life Expectancy and Health Expenditure Evolution in Eastern Europe—DiD and DEA Analysis, *Expert Review of Pharmacoeconomics & Outcomes Research*,

Nixon, J and Ulmann, P. (2006). The Relationship Between Health Care Expenditure and Health Outcomes: Evidence and Caveats from Causal Link. *Eur J Health Econom* 7, 7-18

Karaman, S., Urek, D., Demir, I. B., Ugurluoglu, O. and Isik, O. (2020) The Impact of Health Spending on Health Outcomes: New Evidence from OECD, *Erciyes Med J* 42(2) 218-222

McKeown T (1979) The Role of Medicine: Dream, Mirage or Nemisis? Basil Black well: Oxford

OECD/CRE DES (2000) OECD health data 2000. A software package for international comparison of health care systems. OECD/CRE DES: Paris

Rad, E. H, Vahedi, S., Teimourizad, A., Esmaeilzadeh, F., Hadian, M., Pour, A.T. (2013). Comparison of the Effects of Public and Private Health Expenditures on the Health Status: A Panel Data Analysis in Eastern Mediterranean Countries. *Int J Health Policy Manag*, 1(2): 163–7

Preston, S. H. (1975). The Changing Relation between Mortality and Level of Economic Development, *Population Stud.* 29, 231–48.

Retzlaff-Roberts, D., Chang, C. F. and Rubin, R. M. (2004): Technical efficiency in the use of health care resources: a comparison of OECD countries. *Health Policy* 69(1), 55–72

Swift, R. (2011). The Relationship Between Health and GDP in OECD Countries in the Very Long Run, *Health Economics. Vol 20(3).* Pp 306-322

Wang, K-M. (2011). Health Care Expenditure and Economic Growth: Quintile Panel Type Analysis. *Economic Modelling 28* 1536-1549

Ye, L. and Zhang, X. (2018). Nonlinear Granger Causality Between Health Care Expenditure and Economic Growth in the OECD and Major Developing Countries. *International Journal of Environmental Research and Public Health* 15

Wang, F. (2015). More Health Expenditure, Better Economic Performance? Empirical Evidence from OECD Countries. *Journal of Health Care Organization and Financing 1-5.*

3. Public sector digitalization and the economy

3.1. Motivation and definitions

Digital transformation has been happening all around the world and has impacted the governments, businesses, and the lives of individuals. This will evidently impact expectations of different actors such as individuals, businesses, and governments. To satisfy these expectations governments have undertaken a paradigm change in their support and uptake of digital opportunities (Welby, 2019). The change taking place across governments is from electronic government (e-government), which is using technology to digitise current procedures and services in pursuit of efficiency gains to digital government, which is utilizing data and digital technologies to reconsider and re-structure how governments deliver public value for purpose of developing open, innovative and collaborative governance (Welby, 2019).

What is digital government? The digital government is defined by OECD as "*the use of digital technologies, as an integrated part of governments' modernisation strategies, to create public value. It relies on a digital government ecosystem comprised of government actors, non-governmental organisations, businesses, citizens' associations and individuals which supports the production of and access to data, services and content through interactions with the government*." It is important to notice that it is about generating public value via digitalization of government. This public value could be measurable and quantifiable for purpose of finding new ways for improving government digitalization and hence enhancing value of it. Therefore, public sector digitalization or government digitalization raises important questions regarding the economic consequences of this process. This literature review explores the socio-economic effects of public sector digitalization via open government data.

3.2. E-government and socio-economic indicators

As abovementioned e-government is prior stage of digital government, and hence, previous studies have focused on economic consequences of e-government from different dimensions. Due to data limitations and measurement concerns, studies have own shortcomings in assessing the economic impact of e-government. Picci (2006) have investigated the possible accurate ways of measuring the economic impact of e-government in Italian region of Tuscany. Picci (2006) draw attention to the lack of data in order to make more robust statistical analysis of economic effects of e-government and suggested a structural modelling technique for observing the relationship in different simulation models. Therefore, although this study puts forward methodology for quantifying the relationship, this study provides limited quantitative results. In developing country context, Majeed (2020) have studied the association between e-government and economic growth by using dataset from 122 developing economies over the period 2003–2015. Their results demonstrate that implementation of e-government in developing countries has a positive impact on the

economic growth. More specifically, 1% increase in e-government increases the economic growth by 0.2%.

Another mechanism that e-government may produce positive economic outcomes via limiting illegal activities such as informal economy (also shadow economy) and corruption. Informal economy has been a problem in Baltic region (Meriküll and Staehr, 2010). According to the Putniņš and Sauka (2015), in 2013, size of informal economy for Baltic countries, Latvia, Estonia and Lithuania were about 23.8%, 15.7% and 15.3% of GDP, respectively. Therefore, one may argue that e-government would be one important way to reduce informal economy. Empirical studies also show results in favor of this argument. For instance, employing fixed effects and panel data models, Elbahnasawy (2021) studied the relationship between e-government and informal economy. Elbahnasawy (2011) shows that e-government is crucial instrument to reduce the informal economy. More specifically, the impact of an increase in e-government index by 0.1 point, or a 10% increase, ranges from 1.4 to 2% decrease in the size of the informal economy. The average effect of a 0.1-point increase in e-government ranking across is a reduction in the size of the informal sector by around 1.6%, ceteris paribus. Furthermore, the magnitude of this negative effect is larger in long term than short term. Hence, it may suggest that implementation of e-government takes times and may substantially impact economic actor's decision about formal and informal economy in favour of formality.

Corruption is another problem which harms society and economy. Cost of corruption is estimated to be 5% of world GDP (UN, 2018). E-government is expected to tackle corruption if this policy coupled with effective law enforcement. Past studies have also emphasized the role of e-government as an anti-corruption strategy. (e.g. Andersen, 2009). E-government may curb petty corruption as e-government system may facilitate red tape, reduce long-waiting hours and non-transparent processes (Sheryazdanova and Butterfield, 2017). In other words, e-government may play important role in reducing administrative burden (Ntaliani and Costopoulou, 2018), thus, there will be less room for petty corruption. Longitudinal (2003–2010) analysis of this relationship across 80 countries was performed in study of Zhao and Xu (2015). Their findings show that the development of e-government is negatively associated with corruption perceptions. These results suggest that the further development of e-government through policy initiatives could be effective in reducing corruption.

So far, literature review has provided adequate support for positive economic outcomes of public sector digitalization. Another important dimension for consideration is well-being of individual. Both subjective e.g. life satisfaction and objective well-being e.g. income are important determinants of political activeness and participation of individuals (see e.g. Flavin and Keane, 2012). Also well-being is positively correlated with prosocial behaviours. Welby (2019) has studied the possibilities of digitally transforming government services to enhance citizen well-being both in terms of technology, but also via the role which citizens must play in a 'user-driven' state. Digital governments should provide greater transparency and

openness to citizens which they feel safe and freedom for asking difficult questions (Welby, 2019)

3.3. Public sector digitalization and socio-economic indicators

Effect of public sector digitalization on economy is mainly assessed through the impact and use of open data. However, it is not easy to quantify the economic consequences of open data (hence, public sector digitalization) since benefits and repercussions tend to be indirect. What is open data? Open Data Handbook defines open data as "*Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and share alike.*"[6] One can narrow down this definition to Public Sector Information (PSI), or Open (Government) Data, which is to say data collected and published by the public sector (Carrara et al., 2015). Government data can be defined as "*Government data: is any data and information produced or commissioned by public bodies.*" (Ubaldi, 2013). Therefore, Open Government Data (OGD) combines definitions of Open data and Government data, and is a philosophy- and increasingly a set of policies - that encourages and promotes government accountability, transparency, responsiveness, democratic control and value creation by making government data available to all including, citizens, civil society, wider economy, private sector and public service market place (Ubaldi, 2013). PSI is defined by OECD (2008) as "*information, including information products and services, generated, created, collected, processed, preserved, maintained, disseminated, or funded by or for a government or public institution*". Consequently, studying the economic impact of public sector digitalization through assessing economic value of open government data would help to widen our understanding of public sector digitalization.

According to the European Open Data Maturity Index, Estonia has climbed from 27th place to 5th place between 2019 to 2020[7]. European Data Portal researchers Esther Huyer and Laura van Knippenberg have estimated that the potential open data market size for Estonia could reach a total of €445 million by 2025[8]. However, still further investigation needed to evaluate economic impact of open data for current and future states in Estonia.

Huyer and van Knippenberg (2020) have studied the economic effect of open data on employment in European countries. According to the Huyer and van Knippenberg (2020) market size of open data was 184.45 billion EUR in 2019, it is anticipated to reach between 199.51 - 334.20 billion by 2025. Employment creation possibility of open data is also enlarging. While number of open data employees was 1.09 in 2019, it is forecasted to reach

[6] Website: https://opendatahandbook.org/guide/en/what-is-open-data/

[7] https://www.europeandataportal.eu/sites/default/files/country-factsheet_estonia_2020.pdf

[8] https://www.europeandataportal.eu/en/news/economic-impact-open-data-estonia

between 1.12 – 1.97 million open data employees by 2025. Open data creation impact may vary from sector to sector. High impact sectors are categorized such as public administration; professional, scientific and technical activities; information and communication and ICT; transportation and storage; whereas high potential sectors are agriculture; financial services and insurance; health; education; wholesale retail and trade; real estate activities (Huyer and van Knippenberg, 2020)

Efficiency and cost saving aspects of open data are worthy for attention. Three important efficiency points are listed by Huyer and van Knippenberg (2020). First, around 54 000 - 202 000 human lives saved due to faster emergency response. Second, 27 million hours saved due to more efficient public transport. Third, environmental aspect which 5.8 Mtoe* by decreasing household energy consumption. Huyer and van Knippenberg (2020) reported four main cost saving types which open data impacted the most. This report used open data from Denmark for obtaining expected cost savings for government spending and applied to the EU countries. Accordingly, the accumulated cost savings for 2020 are estimated to be around €1.7 billion. Costs saved based on types. First, because of faster first aid by bystanders, healthcare costs decreased around €312 000 - €400 000. Second, by decreasing time spent in traffic, labour costs was reduced by €13.7 - €20 billion. Third, as more solar energy production, energy costs was reduced by €79.6 billion. Fourth, due to lower translation costs, public sector costs was saved by €1.1 billion.

The Kyiv School of Economics (2018) has estimated the direct open data market size in Ukraine by employing the methodology of Carrara et al. (2015). Their estimation results demonstrate that open data market size is forecasted to be between 0.19% and 0.23% of GDP in 2017, or between USD 213 and 258 million (in constant 2017 prices). In addition, indirect effect of open data on economy is forecasted to be between USD 533 and 635 million, or between 0.48% and 0.58% of GDP in 2017. The overall economic effect of open data is therefore forecasted to be between USD 746-903 million or 0.67% and 0.81% of GDP in 2017. The Kyiv School of Economics (2018) has also made estimations for year 2025 based on three different scenarios. Open data market size (USD, millions) for the scenarios Stagnation, Moderate progress, and Significant progress will be equal to between 953-1,154; 1,095-1,326; 1,162-1,407, respectively. Open data share of GDP for the scenarios Stagnation, Moderate progress, and Significant progress will be equal to between 0,62-0,75%; 0,72-0,87%; 0,76-0,92%, respectively. In employment context, The Kyiv School of Economics (2018) has provided for employment effects of open data. They estimated the share of workers in knowledge intensive activities directly involved in open data related activities to be 3000 to 4000 workers. By 2025, it is forecasted to be 1,400 - 1,900 higher.

Deloitte Access Economics (2015) published a report that analyses the economic effects of digitizing government customer transaction services by assessing government and citizen benefits, and costs to government in Australia. According to the report, 811 million transactions are done every year and 40 % of them done via traditional ways such as face-to

face, telephone or postal. Given the assumption of reduction, these transaction to 20% from 40% for next 10 years (until 2025), they forecast value of benefits (productivity, efficiency etc.) to government would be $17.9 billion. Citizen benefits will encompass savings in time, convenience and out-of-pocket costs which equates to a further $8.7 billion. These will in total cost around $6.1 billion due to new ICT and transitional arrangements. Net economic benefit is $17.9+ $8.7- $6.1= $20.5. This value is equal 1.3% of annual Gross Domestic Product or about $880 in net benefits per Australian citizen or $2,000 per household. They identified six main barriers: (1) Policy bottlenecks and bureaucratic inertia, (2) Budget and capability constraints. (3) Digital exclusion and divide, (4) Lack of competition, (5) Privacy and security, (6) Transitioning government staff to new roles. (Deloitte Access Economics, 2015). If these barriers are achieved with less friction, realisation of possible socio-economic benefits will be expected to be higher for both government and citizens.

This chapter explored the economic consequences of public digitalisation in articles published in peer-reviewed journals and reports. This review can be divided into two based on the digitalization stage of public sector: electronic government and digital government stages. Empirical studies have shown net economic benefits of e-government to the society since it saves resources and times, reduces possible illegal activities such as corruption and informal economy. Regarding the digital government, studies revealed substantial economic benefit of digital government by emphasising total economic value of open data (open government data). Table 4 summarizes the findings from different studies regarding e-government and open data.

Table 4. Summary of results across studies elaborated in literature review

Open data and economy		
Study	Region	Results
Huyer and van Knippenberg (2020)	*EU*	Market size of open data was 184.45 billion EUR in 2019. By 2025, 199.51 - 334.20 billion.
Kyiv School of Economics (2018)	*Ukraine*	Open data share of GDP. 0.67% and 0.81% of GDP in 2017. By 2025 expected to reach 0,62-0,92%.
Deloitte Access Economics (2015)	*Australia*	By 2025, net economic benefit is $17.9+ $8.7- $6.1= $20.5 billion. This value is equal 1.3% of annual Gross Domestic Product.
Buergi Schmelz (2013):	*Switzerland*	2.2 billion CHF open government data market size or 1.27% of GDP.

E-government and economy		
Study	Country	Results
Majeed (2020)	*122 developing countries*	1% increase in e-government increases the economic growth by 0.2%.
Elbahnasawy (2021)	*146 countries*	an increase in e-government index by 0.1 point, or a 10% increase, ranges from 1.4 to 2% decrease in the size of the informal economy.

3.4. References

Andersen, T. B. (2009). E-Government as an anti-corruption strategy. Information Economics and Policy, 21(3), 201-210.

Buergi Schmelz (2013): Wirtschaftliche Auswirkungen von Open Government Data.

Carrara, W., Chan, W. S., Fischer, S., and Van Steenbergen, E. (2015). Creating value through open data. European Union.

Deloitte Access Economics (2015). Digital government transformation. Commissioned by Adobe. Access: https://www2.deloitte.com/au/en/pages/economics/articles/digital-government-transformation.html Date: 16.04.2021.

Elbahnasawy, N. G. (2021). Can e-government limit the scope of the informal economy?. World Development, 139, 105341.

Flavin, P., and Keane, M. J. (2012). Life satisfaction and political participation: Evidence from the United States. Journal of Happiness Studies, 13(1), 63-78.

Huyer, E., and van Knippenberg, L. (2020). The Economic Impact of Open Data: Opportunities for Value Creation in Europe. European Commission.

Majeed, M. T. (2020). Do digital governments foster economic growth in the developing world? An empirical analysis. NETNOMICS: Economic Research and Electronic Networking, 1-16.

Meriküll, J., and Staehr, K. (2010). Unreported employment and envelope wages in mid-transition: comparing developments and causes in the Baltic countries. Comparative Economic Studies, 52(4), 637-670.

Ntaliani, M., and Costopoulou, C. (2018). E-Government for lowering administrative burden: An empirical research on European rural businesses. International Journal of Public Administration, 41(9), 700-711.

OECD (2008) Recommendation of the Council for enhanced access and more effective use of Public Sector Information‖, Web: https://www.oecd.org/digital/ieconomy/40826024.pdf

OECD (2014), Recommendation of the Council on Digital Government Strategies, OECD/LEGAL/0406, OECD, Paris, Web: https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0406 Accessed: 14 April 2021

Picci, L. (2006). The quantitative evaluation of the economic impact of e-government: A structural modelling approach. Information Economics and Policy, 18(1), 107-123.

Putniņš, T. J., and Sauka, A. (2015). Measuring the shadow economy using company managers. Journal of Comparative Economics, 43(2), 471-490.

Sheryazdanova, G., and Butterfield, J. (2017). E-government as an anti-corruption strategy in Kazakhstan. Journal of Information Technology & Politics, 14(1), 83-94.

The Kyiv School of Economics (2018) available at: http://tapas.org.ua/en/media/ekonomichnyj-potentsial-vidkrytykh-danykh-v-ukraini/

Ubaldi, B. (2013). Open government data: Towards empirical analysis of open government data initiatives. OECD Working Papers on Public Governance No. 22

United Nations (2018). Website: https://www.un.org/press/en/2018/sgsm19392.doc.htm Accessed: 15.04.2021.

Welby, B. (2019). The impact of digital government on citizen well-being. OECD Working Papers on Public Governance No. 32. https://dx.doi.org/10.1787/24bac82f-en

Zhao, X., and Xu, H. D. (2015). E-government and corruption: A longitudinal analysis of countries. International Journal of Public Administration, 38(6), 410-421.