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"Exploring the relationship between innovation and social welfare: Insights from global indices"

Konstantinos Gatos

Supervisor: Prof. Chountalas Panagiotis

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"Exploring the relationship between innovation and social welfare: Insights from global indices"

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Supervising Committee

Supervisor:	Co-Supervisor:
Panagiotis Chountalas	Maria Argyropoulou

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"to my wife Irene and my children Orestis, Aris, Marios"

"great thanks to the Supervising Committee, and especially grateful to Dr. Chountalas, for his suggestions, guidance, and continuous support throughout this dissertation."

Abstract

Current study examines the relationship between innovation and social welfare under the prism of global indices. The innovation metrics used relate to the Global Innovation Index and the number of patent applications per origin while welfare metrics refer to Gross Domestic Product per capita, Human Development Index, Happiness Report and Job Satisfaction. Aggregated datasets from around the globe indicate a fair correlation of innovation with the social welfare for the various regions. The proportion of variance of the welfare parameter that is explained by an innovation factor has been expressed by the R square coefficient of determination for each region around the world. The analysis has identified that correlation suffers by countries in which their economy is based solely on their natural resources, confront significant inequalities in their population and the society bears low trust in institutions. The existence of countries with high GDP per capita which diverge however from the correlation implies that foreign direct investments for the exploitation of natural resources without the ability of the relevant country to build knowledge does not improve its positioning on the innovation board. In current analysis the functionings of the regions which are needed to evolve their endogenous growth have been constructed wherein improvements in institutions and infrastructure appear important for the least developed regions while business and market sophistication grants more merit to the developed ones. In every scenario, human development and sufficient credit were the cornerstones of innovative progress. The models developed were proven regarding their robustness and the stability of their regression coefficients through the Variance Inflation Factor technique. It appears that the economic growth that is generated within a country is fostered by internal processes such as the national innovation systems which may enhance the capabilities of the citizens through relevant policies. The positive correlation of the very satisfied employees with the innovation score depicts that the latter may improve the wellbeing of the society, which in turn may enhance further the functionings of the people. A closer look on the case of Greece is considered which although lays at the low levels of the European Union in terms of its social welfare, yet it is positioned at an expected level considering its rather low innovative score.

Keywords

Global indices, Innovation, Welfare, Human Development, Endogenous Growth.

"Διερεύνηση της σχέσης μεταξυ καινοτομίας και κοινωνικής ευημερίας: Στοιχεία από παγκόσμιους δείκτες" (in Greek)

Κωνσταντίνος Γάτος

Περίληψη

Η τρέχουσα μελέτη εξετάζει τη σχέση μεταξύ καινοτομίας και κοινωνικής ευημερίας υπό το πρίσμα παγκόσμιων δεικτών. Οι δείκτες που εξετάστηκαν αναφέρονται στον παγκόσμιο δείκτη καινοτομίας και τις αιτήσεις πατεντών ενώ οι δείκτες ευημερίας συνδέονται με το εθνικό ακαθάριστο προϊόν ανά κάτοικο, τον δείκτη ανθρώπινης ανάπτυξης, την αναφορά στην ευτυχία και την ικανοποίηση στην εργασία. Συγκεντρωτικά στοιχεία από όλον τον κόσμο αποτυπώνουν μια ικανοποιητική συσχέτιση της καινοτομίας με την ευημερία για τις διάφορες περιοχές του κόσμου. Η αναλογία της μεταβλητότητας της ευημερίας που εξηγείται από την καινοτομία εκφράστηκε με τον συντελεστή προσδιορισμού για την κάθε περιοχή του πλανήτη. Η ανάλυση έδειξε ότι η συσχέτιση πάσχει σε χώρες στις οποίες η οικονομία τους βασίζεται αποκλειστικά στους φυσικούς πόρους, που έχουν σημαντικές ανισότητες στον πληθυσμό και η κοινωνία τους έχει χαμηλή εμπιστοσύνη στους θεσμούς. Η εμφάνιση χωρών με υψηλό εθνικό ακαθάριστο προϊόν ανά κάτοικο που αποκλίνει από την συσχέτιση υποδεικνύει ότι οι άμεσες ξένες επενδύσεις για την αξιοποίηση του εθνικού πλούτου χωρίς η χώρα να έχει την δυνατότητα να χτίσει νέα γνώση δεν βελτιώνει τον βαθμό καινοτομίας της χώρας αυτής. Στην τρέχουσα ανάλυση αποτυπώθηκαν οι λειτουργίες που χρειάζονται για να ευδοκιμήσει η ενδογενής ανάπτυξη των περιοχών. Οι αναπτυσσόμενες περιοχές χρειάζεται να βελτιώσουν θεσμούς και υποδομές ενώ οι ανεπτυγμένες χώρες χρειάζονται εξειδίκευση στις επιχειρήσεις και στην αγορά. Σε κάθε σενάριο όμως η ανθρώπινη ανάπτυξη και οι πιστώσεις αποτελούν ακρογωνιαίο λίθο για την πρόοδο στην καινοτομία. Τα μοντέλα που αναπτύχθηκαν ελέχθησαν επιτυχώς για την σταθερότητα των συντελεστών συσχέτισης παρακολουθώντας τον συντελεστή διόγκωσης της διακύμανσης. Φαίνεται ότι η οικονομική ανάπτυξη μιας χώρας ενισχύεται από εσωτερικές διαδικασίες όπως το εθνικό σύστημα καινοτομίας που βελτιώνει τις δυνατότητες των κατοίκων μέσω

των σχετικών πολιτικών. Η θετική συσχέτιση των πολύ ικανοποιημένων εργαζομένων με τον δείκτη καινοτομίας δείχνει ότι η καινοτομία μπορεί να βελτιώσει το ευζήν το οποίο με τη σειρά του βελτιώνει την λειτουργία της κοινωνίας. Μια προσεκτική ματιά στην περίπτωση της Ελλάδας δείχνει ότι ενώ είναι στις χαμηλές θέσεις της Ευρωπαϊκής Ένωσης σε κοινωνική ευημερία, παρόλα αυτά είναι σε λογικό επίπεδο σε σχέση με το επίπεδο καινοτομίας το οποίο κατέχει.

Λέξεις – Κλειδιά

Παγκόσμιοι δείκτες, Καινοτομία, Ευημερία, Ανθρώπινη Ανάπτυξη, Ενδογενής Ανάπτυξη.

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List of Abbreviations & Acronyms

GII – Global Innovation Index

GIS – Global Innovation Score

GNI - Gross National Income

GDP -Gross Domestic Product

WIPO - World Intellectual Property Organization

UNCTAD - United Nations Conference on Trade and Development

OECD - Organization for Economic Cooperation and Development

UNDP - United Nations Development Program

WHR - World Happiness Report

ILO - International Labour Organization

UNU-WIDER - United Nations University World Institute for Development Economics Research

ESSPROS - European System of integrated Social PROtection Statistics

PCT - Patent Cooperation Treaty

NIS – National Innovation System

HCRS - Human Capital and Research Score

BSS - Business Sophistication Score

ICTS – Information and Communication Technology Score

MSS – Market Sophistication Score

IS – Institutions Score

CS - Credit Score

CSA – Central Southern Asia

EUR – European Union 27 countries

LCN – Latin America and Caribbean

NAC – Northen America and Canada

NAWA – Northen Africa and Western Asia

non-EU – European countries outside the Union

SEAO – South East Asia and Oceania

SSA – Sub Saharan Africa

ANOVA - Analysis of Variance

VIF - Variance Inflation Factor

OLS – Ordinary Least Squares

R&D – Research and Development

1. Introduction

Indices from global reports are often used by researchers to monitor and compare the performance of regions and nations around the world. Such indices gather valuable data to benchmark and guide policy makers into decisions for research and development, social expenses, infrastructure investments and educational programs.

1.1 Global reports on innovation

One of the most popular reports for innovation appears to be the Global Innovation Index (GII) report, which compiles data from over 130 countries around the world. It is published annually by the World Intellectual Property Organization (WIPO) and uses tools for measuring research and development, investments and technology adoption in top performers and laggards (WIPO, 2024). Since 2007, GII has been continuously supporting governments and individuals on data-driven decisions that enable holistic progress and development.

WIPO is also releasing annually the PCT Yearly Review which reports the international patent applications by country of origin under the Patent Cooperation Treaty (PCT). This is an international agreement for inventors who, in a simplified way, are seeking patent protection in multiple countries around the world (WIPO, 2025). In general, for weighing the annual innovative potential of a country, the number of its PCT applications is preferable rather than the number of granted patents since the former provides a real time snapshot of the technological development shortly after its birth rather than the jurisdiction-depending outcome of a long-lasting process that relates with the latter case.

The United Nations Conference on Trade and Development (UNCTAD) publishes a report on technology and innovation compiling data from more than 130 countries around the world. Subjects of the report relate to international trade, finance and investments, maritime and transport, environment, population and technology. UNCTAD keeps pace with technological advancements handling issues of high global interest such as the recent booming development of artificial intelligence (UN Trade, 2025).

Likewise, the Organization for Economic Cooperation and Development (OECD) gathers statistics about the innovation activities and outcomes of firms from its member states as well as from other economies, which are published every two years. The reports outline policy priorities to strengthen the foundations for economic growth through the enhancement of markets' functioning and incentives (OECD, 2026).

Moreover, other organizations like PwC (Staack, 2017), KPMG (KPMG International, 2026), McKinsey (McKinsey & Company, 2025), WEF (World Economic Forum, 2025), Stimson Center (Stimson Center, 2025), etc. are publishing reports on innovation, which explore ways to overcome barriers for change and development.

Especially for Europe, there are tools like the European Innovation Scoreboard for measuring the innovative level of its member states (European Commission, 2024). This tool is especially suitable for the European policy makers and the national governments for designing the multilevel convergence criteria of the member states and directing funding, accordingly.

1.2 Global reports on social welfare

Nowadays, the approach of many governments to pay attention to the wellbeing of their society is considered crucial for these countries to develop their full potential and meet their governmental expectations (Helliwell, 2008). In this view, global records on measuring social welfare are beneficial. An important and popular report to this direction is the Human Development Report published annually since 1990 by the United Nations Development Program (UNDP). The significance of this documentation is that it considers humans as the cornerstone of development rather than focusing on economy and trade (UNDP, 2025).

Similarly, the World Happiness Report (WHR) produced by the partnership of Gallup, the Oxford Wellbeing Research Centre, the UN Sustainable Development Solutions Network, and the WHR's Editorial Board gathers data on life satisfaction and wellbeing of the population from over 140 countries around the world (Helliwell, 2024). Additionally, the Organization for Economic Cooperation and Development (OECD) reports periodically on the state of wellbeing in the OECD countries. By this way, the Organization is trying to identify opportunities from global crisis for learning and for action, fostering resilience in the economies and the societies (OECD, 2024).

Moreover, other institutions like the International Labour Organization (ILO) publishes since 2015 the World Social Protection Report on social protection along with the climate crisis (ILO, 2025). The United Nations University World Institute for Development Economics Research (UNU-WIDER) publishes the World Social Report aiming to promote solidarity, cooperation and social cohesion (UN, 2025). In the same direction, the World Bank Group releases the World Development Report - WDR (World Bank, 2025a) as well as other works such as the Poverty and Shared Prosperity (World Bank, 2022) or the State of Social Protection Report (World Bank, 2025b) discussing ways to close the coverage gap for the world's poorest.

In case of the EU, Eurostat has developed the European System of integrated Social PROtection Statistics (ESSPROS), providing specific tools for the statistical observation of social coverage in the Member States (Eurostat, 2019).

1.3 Objectives of the study

Current dissertation aims to explore the relationship between innovation and social welfare. This relationship is considered through the analysis of robust global indices that are linked either with innovation or social welfare. Investigation is conducted in global view as well as in distinct regions around the world with known economic and technological differences. Valuable information is provided to researchers and firms who are willing to enlighten their understanding of the potential growth in the various regions around the world and ways to boost further development. It may provide the basis for further research at the international level and additionally, highlight the position of Greece in the global arena.

1.4 Structure of the study

Present dissertation is structured into five chapters: Introduction, Literature Review, Methodology, Results, Discussion, and Conclusions. The first chapter provides an overview of the subject and its objectives. The second chapter presents a comprehensive literature review on the analysis. The third chapter outlines the methodology to be employed. The fourth chapter presents data and correlations and in the fifth chapter, the outcomes of the analysis are discussed. Finally, the dissertation ends with the concluding remarks, relevant limitations and future research directions.

2. Literature Review

2.1 Utilization of indices on innovation and welfare

Indices from global reports relating to innovation and social welfare are currently well accepted and widely used by researchers around the world providing valuable conclusions for further societal development and growth. The analysis below focuses on the most popular, solid and well-established reports, namely the Global Innovation Index (GII), the Human Development Index (HDI) and the Happiness Report, which gather a wide spectrum of innovation and welfare metrics. Further, a comprehensive literature review on growth models is given.

2.1.1 Global innovation index

Global innovation index (GII) is a composite metric that reports the national ranking based on combined indicators relating to Institutions, Human capital and research, Infrastructure, Market sophistication, Business sophistication, Knowledge and Technology outputs as well as Creative outputs (WIPO, 2024). In this way, the GII can record the multidimensional nature of innovation rather than the partial and skewed view that a single parameter captures. Several scholars exploit the Global Innovation Score of a country to identify connections with its welfare. Dempere et al. have identified a significant, positive correlation between a country's GII score and its GDP. Such a result suggests that a nation's economic prowess is intrinsically tied to its innovative capacity (Dempere, 2023). The strong positive correlation between GDP growth and innovation development determined by GII is apparent also in periods of global crisis such as the recent pandemic, wherein governments and business implement innovative solutions to keep economies stable (Vasin, 2024).

Through the GII analysis, it has been proposed that the business sophistication of a country is the most powerful factor on income followed by market sophistication. In this view, commercialization of technology developed through knowledge production, establishment of spin-off companies, international projects, and publications in high impact factor journals contribute to countries' income (Sicakyüz, 2023).

Coutinho and Au-Yong-Oliveira have underlined that the model which determines innovation performance must integrate the business and political environment, promote higher education and research and development, strengthen ecological sustainability, consider the credit system and business investment, as well as ensure knowledge management and innovation partnerships (Coutinho, 2024). Besides, Nasir and Zhang underline the significant role of ICT in the progress of global innovation indexing of national economies (Nasir, 2024). Nevertheless, not all countries transform their innovation inputs efficiently into innovation output results and additionally, a higher innovation output does not always coincide with a higher competitiveness of its economy (Jankowska, 2017).

2.1.2 Human development index

Throughout the previous decades, Human Development Index (HDI) has become a well-accepted sophisticated measure of development as opposed to the traditional and unidimensional gross domestic product (GDP) indexing. The composite metric of HDI compiles national data on life expectancy at birth, expected years of schooling, mean years of schooling and gross national income (GNI) per capita (UNDP, 2025). It should be mentioned that countries with the maximum value of certain factors constituting HDI do not necessarily have a higher HDI value as this index represents the geometric mean of all three relevant elements. Development means more than the expansion of income and wealth within society and grasp the notion of enlarging people's choices (Sagar, 1998). This latter is rather infinite and changes over time. In any case, people look to live a long healthy life, acquire knowledge and gain the means for a decent standard of living.

The dimensions considered within HDI are essential for the development of human capabilities (Bagolin, 2008). In this view, a human development strategy aims to enhance people's quality of life by increasing access to opportunities and resources, rather than targeting solely the increase of the wealth of the economy in which people live. Using the multiple linear regression method, HDI has been found to correlate well with skilled labor force, R&D expenditure, tourism, and export & import (Tobaigy, 2023).

Dasic et al. focused their analysis on the HDI of the western Balkan countries. They have detected a mild continuous increase in HDI indicators, which directs further progress in human development of the relevant societies. Key aspects to ensure further advancement of the HDI components of the western Balkan countries rely to adoption of global strategies and laws, realistic action plans, and the use of knowledge, which enhances people's choices and general welfare (Dasic, 2020).

Puttitanun and Lerskullawat performed a regional analysis on the HDI index. Europe, North America, and Latin America regions, which relate to high- and middle-income economies present a significant correlation between human development and growth. However, regions including low-income countries such as South Asia tend to show insignificant effects, suggesting that lower development levels may limit the extent to which human development contributes to growth. It appears that while human development generally boosts economic growth, its effectiveness may vary by regional income structure and degree of development (Puttitanun, 2025).

2.1.3 Happiness report

Research on happiness and well-being has been attracting considerable attention in social science over the last decades. In this view, the Happiness Report, which considers metrics related to GDP per capita, Social support, Healthy life expectancy at birth, Freedom to make life choices, Generosity and Perceptions of corruption, is positioned as a major indicator of measuring societal happiness (Helliwell, 2024). The countries which are more effective at turning capital and labor into GDP are not always better at transforming their inputs into well-being for their society. It seems that the quality of economic growth matters most (Sarracino, 2022). Such a case appeared in China from 1990 to 2010 where, despite a fourfold multiplication in two decades in real GDP per capita from a low initial level, life satisfaction had not improved as much (Easterlin, 2013).

Based on the Happiness Index data of 2024, Çelic et al. underlined that the happiness levels of African countries are significantly lower than other regions, while European countries have higher happiness levels. Factors having significant effect on happiness relate to social support, GDP per capita and healthy life expectancy (Çelic, 2025). In the example of India, Bhattacharyya et al. presented that a country although with high growth rate can be among the unhappy countries of the world. The analysis highlighted the crucial role of volunteerism, societal environmental concerns, absence of gender gap within the population and excel in healthcare, goals that the high-ranking countries such as Denmark have successfully achieved (Bhattacharyya, 2019). It is interesting to note that the average levels of life satisfaction in societies seem to change little over time, even when large improvements in socio-economic conditions take place. It is speculated that society's relative position in the international league table of economic performance matters more rather than its absolute levels of output for subjective well-being (Fahey, 2004).

Parameters related to the national economy of a country such as the high rate of inflation and the high rate of unemployment are affecting negatively happiness and social welfare (Di Tella, 2006). Besides, in the example of Argentina, Anand et al. have shown that more aspects may have impact on happiness and life satisfaction such as empathy, self-worth, goal autonomy, discrimination, safety and stress (Anand, 2011). Currently, governmental policy frameworks are advised to focus on human well-being instead on sole growth and income for achieving sustainable development (Agraval, 2024). Over and above, analyzing a dataset of 130 countries with observations from 2011 to 2022, Popescu et al. suggested that innovation causes happiness, namely environments characterized by excessive levels of innovation are inclined to exhibit correspondingly higher indicators of resident happiness (Popescu, 2024).

2.2 Development of growth models

Economic growth models provide explanation for the growth state in per capita values of output and consumption. These theoretical frameworks are trying to explain how and why economies expand, providing insights into long-term increases in gross domestic product, productivity, and national living standards. By this way, key economy drivers like investment, technological progress, and capital accumulation, can be identified enabling policymakers to analyze growth paths and design policies to revitalize development.

2.2.1 Schumpeter model

In Schumpeterian growth models, innovation is associated with creative destruction, in which the profit flow of a previous innovator is diminishing or even eliminated by the birth of a new innovator. In this view, firms can be created and destroyed in the process of growth (Jones, 2019). Entrepreneurs require on the one hand technical knowledge to introduce new products or new combinations of production and, on the other hand, need purchase power in the form of credit and capital, which can be provided by banks and other financial institutions. Therefore, credit and banks play an important role in the economic development of a country (Langroodi, 2021).

Economic development in the theory of Schumpeter assigns that the development is a spontaneous and discontinuous change in the channels of the circular flow, disturbance of equilibrium which forever displaces the equilibrium state previously existing. Such an approach consists of new resource combinations, so-called innovations, or technological changes. When innovations or changes such as economic, social, political, and/or technical, take place in the economy, the stationary equilibrium or circular flow is displaced, and the process of development starts. Innovation may be defined as a change in the existing production system introduced by the entrepreneur to make profits and reduce costs (Schumpeter, 1934).

2.2.2 Neoclassical growth model

The Neoclassical growth model is also mentioned in literature as Solow-Swan or Exogeneous. Solow has pioneered the exogenous growth theory reporting that productivity growth can only be explained through direct investment, population increase and technological progress. However, direct investment and population increment only have level effects on output and do not affect the long-run growth rate. Thus, technological progress becomes the only factor that affects the long-run growth rate of the economy, and results in productivity differences between nations in the world. In this view, increasing returns to capital are associated with innovation (Solow, 1956).

The Neoclassical theory implies that the rate of growth driven by technology is determined outside the exogenous model and is independent of any government policy intervention that may be introduced (Chirwa, 2018). For the record, Robert Solow and Trevor Swan independently developed the essentials of what became known later as the neoclassical growth model (Swan, 1956). Nevertheless, the two pioneers of this theory, although finding much to admire in each other's contributions, did not completely endorse every aspect of each other's work (Dimand, 2008).

2.2.3 Endogenous growth model

Endogenous growth models that focus on the accumulation of physical capital assume that the savings have a permanent positive contribution to the long-run growth rate. In this respect, aggregate production functions can exhibit increasing returns to scale if a portion of the capital employed is used for innovative capital (e.g. in the form of improvements in the organization, quality of labour, technical change, etc.) that contributes to technological progress (Frankel, 1962).

Developing further this theory, Romer emphasized that technological change is the result of efforts by researchers and entrepreneurs who respond to economic incentives. Parameters affecting their efforts, e.g. tax policy, basic research funding, and education, etc. can potentially influence the long-run prospects of the economy. The discovery of new ideas lies at the heart of economic growth, and the related stock of human capital determines the rate of growth. Ideas are nonrivals so output per person depends on the overall stock of knowledge. Knowledge can grow at a constant exponential rate, which is proportional to the amount of research effort (Romer, 1990). Besides, ideas that are born in one industry may create endogenous technology spillovers between industries, thus generating innovation waves which in turn advance economic growth (Andergassen, 2002).

2.2.4 National innovation system

Production is considered as a routine process which results in a regular flow of products from the manufacturer to the end user. Besides, innovation is a process of exploration characterized by lower predictability regarding its output. However, production and innovation are mutually dependent. Specifically, knowledge obtained by the daily process of production can nourish developments. In this view, innovations may transform the regular activities of production, boost productivity and reshape future (Lundvall, 2016).

It is quite common production and innovation to take place in distinct environments without any linkage between them. Often, there is cultural distance between the industrial community and the academia exhibiting differences in criteria of success, ambitions, and incentives. Under these circumstances, a reorganization of specific research units to be evolved into problem-oriented units might be beneficial to the academic community and its ability to communicate with external partners. This situation might also have a stimulating effect on academia itself, putting new ideas on the research agenda (Kueffer, 2012).

The network of public and private institutions such as universities, governmental agencies and firms may determine the technological performance of a nation generating its National Innovation System (NIS). The concept of NIS appeared in the late 1980s, proposing a modern framework to describe a systematic approach to innovation (Freeman, 1988). Substantial parts on this system are considered the learning processes, the incentive mechanisms, and the availability of skilled labor. In this view, highly skilled workforce may drive the collaboration between academia and industry, enabled by governmental policies which foster technology transfer and commercialization via the establishment of research parks and technology clusters (Weerasinghe, 2024).

In NIS, the term "national" implies that these elements are located within the boundaries of a specific country. Nevertheless, there is a growing trend towards international linkages in science, technology, and innovation initiatives softening the boundaries of the national innovation system. The innovation systems in developing countries count on the absorption and exploitation of spillover knowledge and external technologies (Kayal, 2008). Such a process requires the creation of absorptive capacity, i.e. the ability to understand and incorporate external technology at firms and national level. Especially regarding the least developed countries, they must confront the complexities of formulating policies for establishing innovation systems within their own contexts (Ho, 2015).

2.2.5 Capability approach

The development of people is a key aspect in innovation processes. The support of individuals on what they can do and be, considering however real opportunities including being educated, healthy, and participating in society, enables a high quality of life. For wellbeing the focus appears to be on human capabilities and on the functionings that make their life valuable. Functionings are influenced by personal, social, and environmental factors (Oosterlaken, 2009). Capability is a set of functionings representing the various alternative combinations of beings and doings therefore capability could be considered as the space of functionings (Sen, 1993). Each person should have the same real opportunity (capability) however individuals are responsible for their choices (functionings). In practice there are great differences in quality of life based on capabilities and functionings around the world (Robeyns, 2006).

It appears that public policy intervention should create an institutional framework for individuals to provide capabilities, advance wellbeing and drive happiness (Adler, 2016). Evidently, a discrepancy in functioning achievement between people who report the same level of happiness may arise. This phenomenon can be implied through the so-called hedonic adaptation which turns individuals into adapting to misfortune as a mechanism for them to overcome bad conditions. Hedonic adaptation can prolong undesirable social outcomes because people are not motivated to change their situation. From this standpoint, policymakers may conclude to take no action as the subjective well-being levels are measured high (Binder, 2013).

2.2.6 Outlook of development models

The systemic approaches to innovation continue to concern plethora of empirical studies in literature. The models used by researchers act as a framework to carry out country-level comparisons of technological performance and international evaluations on innovative strength. The process of innovation is continuous and cumulative characterized mainly by creativity of the individuals for identifying the non-obviousness, rather than a routine and rational decision-making approach. The idea generation through the Schumpeterian perspective advances economic growth while the national innovation systems may bring effectively the concept into the real economy. In this respect, social and educational systems, working conditions, salaries and wages as well as income taxes may be designed to expand the capabilities on learning. At the level of the firms, subsidies, patent laws and tax rules, including depreciation allowances for investment in tangible and intangible resources, may motivate further innovation activities. Technological change may arise as an outcome of endogenous growth which will augment job satisfaction whilst neoclassical viewpoints fall short. Yet, social welfare can relate to innovation under various prisms. State regulations on working conditions and the formation of trade unions can play a supplementary role in making growth socially sustainable. After all, successful countries in innovation have flourished in strong states by promoting general education, creating learning societies and supporting industries which generate learning externalities (Greenwald, 2013).

3. Methodology

3.1 Databases and relevant indices

The methodology used in current analysis exploits global indices by extracting relevant data into a structured and quantitative extrapolation to benchmark and compare the performance across different regions and countries around the world. The analysis uses standardized and aggregated metrics, which relate to innovation and welfare indicators. These indices are included in reports that are widely accepted by industry and academia and are shown in Table 1.

Category of Index	Name of Report	Year of Publication	Selected Parameter
Innovation	Global Innovation Index (GII), (WIPO, 2024)	2024	Innovation score of 2023 (Pages 116-248)
Innovation	PCT Yearly Review, (WIPO, 2025)	2025	PCT applications filed by country of origin in 2024 (Pages 41-43)
Welfare	World Happiness Report (WHR), (Helliwell, 2024)	2024	Life evaluation score of 2021-2023 (Pages 15-17)
Welfare	Human Development Index (HDI), (UNDP, 2025)	2025	Human development score of 2023 (Page 274)
Welfare	Eurobarometer – Investing in Fairness, (EC, 2025)	2025	Job satisfaction percentage measured in January 2025

Table 1. The Reports used in current analysis which relate to innovation and social welfare

3.2 Data used for the Graphs

For exploring the relationship between innovation and social welfare, multi-dimensional data from 131 countries around the world have been analyzed and compared. The scores of the parameters are grouped into the regions shown in Table 2 for extracting comparative conclusions.

Countries	**Region**
India, Bangladesh, Iran, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan, Uzbekistan	Central Southern Asia (CSA)
Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden	European Union 27 countries (EUR)
Brazil, Chile, Mexico, Argentina, Barbados, Bolivia, Colombia, Costa Rica, Dominikan, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Trinidad, Uruguay	Latin America and Caribbean (LCN)
USA, Canada	Northen America & Canada (NAC)
Israel, UAE, Turkey, Morrocco, Algeria, Armenia, Ajerbaijan, Bahrain, Egypt, Georgia, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Tunisia	Northen Africa and Western Asia (NAWA)
UK, Switzerland, Russia, Albania, Bosnia, Iceland, Montenegro, North Macedonia, Norway, Moldova, Serbia, Belarus, Ukraine	European countries outside the Union (non-EU)
Singapore, China, Korea, Japan, Malaysia, Vietnam, Philippines, Australia, Brunei, Cambodia, Hong Kong, Indonesia, Laos, Mongolia, Myanmar, New Zealand, Thailand	South East Asia and Oceania (SEAO)
South Africa, Senegal, Uganda, Ghana, Namibia, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Cote d'Ivoire, Ethiopia, Kenya, Madagascar, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Togo, Tanzania, Zambia, Zimbabwe	Sub Saharan Africa (SSA)

Table 2. The countries around the globe that have been considered for index analysis

The reports used in current analysis do not correspond exactly to the same period since there is a lag in their publication by the relevant authorities. Nevertheless, their coherence is evident especially for GII, HDI and WHR and they relate well with information gathered from the year 2023. The World Intellectual Property Organization (WIPO) released in 2025 the number of international patent applications by country of origin (PCT System) which relates to the year 2024. The Eurobarometer conducted on January 2025 interviews from citizens all around Europe on the satisfaction of the population on national and domestic issues. However, a fair connection should be considered also to the data that appeared a year later than 2023 such as the number of patent applications and job satisfaction percentage. On the one hand, a patent application requires a reasonable period to be developed and filed, thus PCTs of 2024 relate well with the research conducted within 2023. On the other hand, an employee may establish an opinion on fairness and satisfaction in working environment based on consolidated feelings throughout a recent period in the past. For normalization and correlation analysis, the GDP and population of each country were collected through the GII report.

3.3 Multiple regression

The data of global reports have been correlated by means of multiple regression analysis utilizing the Microsoft Excel tool of Microsoft Office suite. The components of GII in terms of its input and output scores have been investigated. Relevant equations have been constructed relating innovation with welfare parameters along with their coefficient of determination for calculating the proportion of variance in the dependent variable that is explained by the independent variable. In this view, the multiple regression ANOVA (Analysis of Variance) has estimated if the regression models constructed with multiple predictors can explain a significant amount of variance in the respective dependent variable. The analysis was run for 120 countries since relevant data were not available for Belarus, Barbados, Trinidad, Rwanda, Oman, Qatar, Cabo Verde, Burundi, Brunei, Moldova and Angola. Moreover, multiple regression has no sense for the NAC region as it relates to only two countries, namely USA and Canada and it results to the unit.

Validation check regarding robustness in the global models has been performed to verify the stability of the regression coefficients and the value of the present findings. Therefore, multicollinearity was investigated wherein the predictors were analyzed through the Variance Inflation Factor (VIF) technique. Every independent variable of the global models was treated as dependent, and it was regressed against all other independent variables in each model. This method was repeated for every predictor in the models. In this way, the coefficient of determination (R2 value) represents the degree that the variance in one variable is explained by the other predictors and multicollinearity through VIF is calculated by the ratio 1/(1-R2). In general, values lower than 5 relate to moderate correlation which is not problematic, while values higher than 10 indicate high correlation and the estimates are unreliable.

To verify the reliability of the multiple regressions which have been applied in the global models, the heteroscedasticity occurrence has been examined. The variance of the residuals is investigated across all levels of the independent variables. Any created scheme of "fan" or "cone" shape in the residual plots points heteroscedasticity and violates the assumption of constant variance. In that event, the spread of residuals is changing with the predictor and presents a pattern rather than a random scatter. As a result, ordinary least squares (OLS) become inefficient with inaccurate standard errors. Such a performance may indicate misspecification of the respective model, omitted variables, and presence of outliers.

4. Results

4.1 Correlation of innovation with welfare

The investigation of the relationship between innovation and social welfare is examined considering the welfare parameters as the dependent variable and the innovation parameters as the independent ones. Various combinations of welfare and innovation parameters are correlated and presented in current analysis.

The GDP per capita finds a lot of debate yet could be considered as a fair approximation to the welfare of the citizens (Schuller, 2014). The GDP per capita versus the Global Innovation Score (GIS) for 131 countries around the globe is depicted in Figure 1.

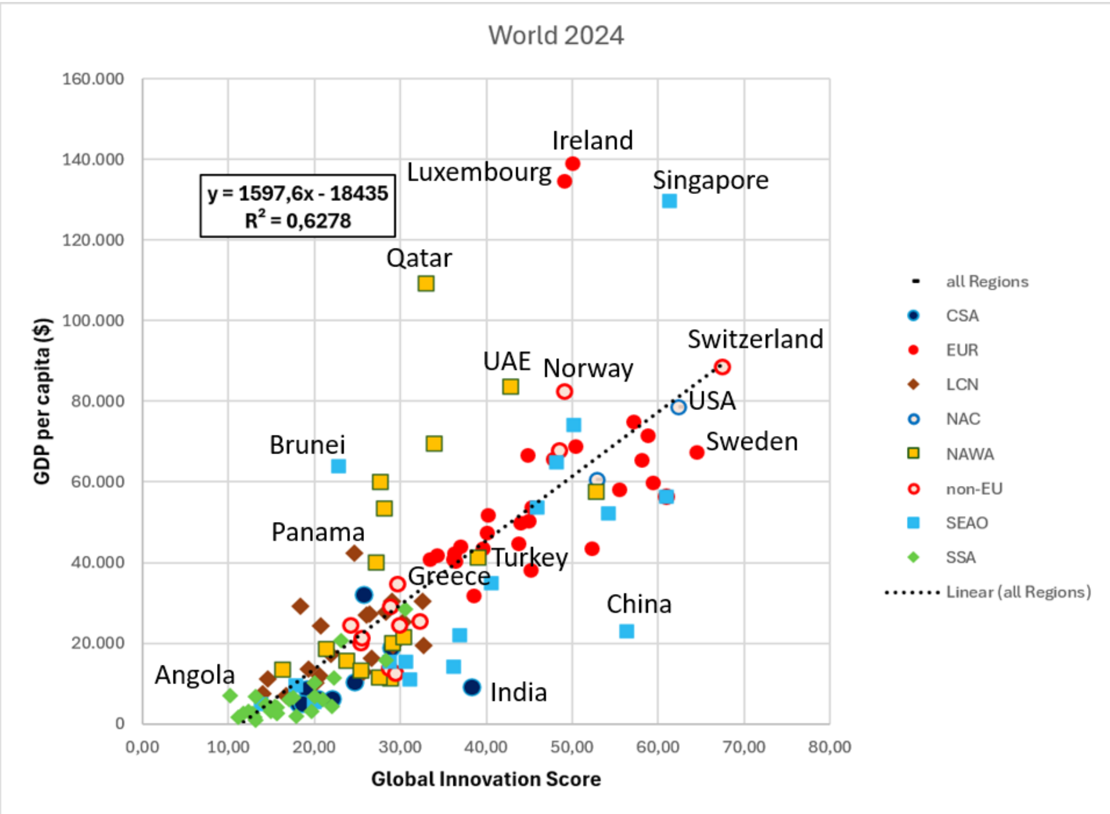

Figure 1. The GDP per capita versus the Global Innovation Score of the 131 countries from all around the globe

A quite good correlation of the parameters is revealed as R2 receives the value of 0.6278. The region of SSA lays in the low range of the graph while the most developed countries appear at the upper part of the linear regression.

While these two parameters seem to correlate well with the whole sample of 131 countries, it is interesting to investigate how the GDP per capita correlates with GIS in a linear regression for every region around the globe. Table 3 shows the R2 of those correlations while the relevant graphs can be found in the Appendix A of Figures. Note that the NAC region is not included since it considers only two countries thus its correlation is receiving the value of one.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.6294	0.4638	0.8025	0.3091	0.3088	0.1095	0.2289

Table 3. The R square of the correlation between GDP per capita and Global Innovation Score for each region around the globe

As can be seen in Table 3, the GDP per capita correlates well with GIS for SSA and the non-EU countries, while the CSA region presents the lowest correlation. The reason behind CSA performance relates to Kazakhstan which possesses huge reserves of oil, gas and minerals and attracts high levels of foreign investments which however do not produce the respective innovative outcome. Besides, EUR shows low correlation due to the outliers of Ireland and Luxembourg which although have a very high GDP per capita do not present the corresponding innovative potential. This latter is connected with their economy which receives outstanding capital from around the globe due to specific taxation that these countries apply. Similarly, rich countries like Qatar in the NAWA region, due to their wealth on natural resources e.g. petroleum, present a high GPD per capita with moderate innovative score. By the same way, Panama is positioned as outlier in LCN graph (see Appendix A) as the service-oriented economy based on the canal produces significant revenues through tolls, banking and logistics.

Advancements in measuring welfare have led researchers to the composite parameter of HDI, although it nowadays finds some criticism about its universal use (Amendola, 2023). The HDI versus the Global Innovation Score (GIS) for 131 countries around the globe is depicted in Figure 2.

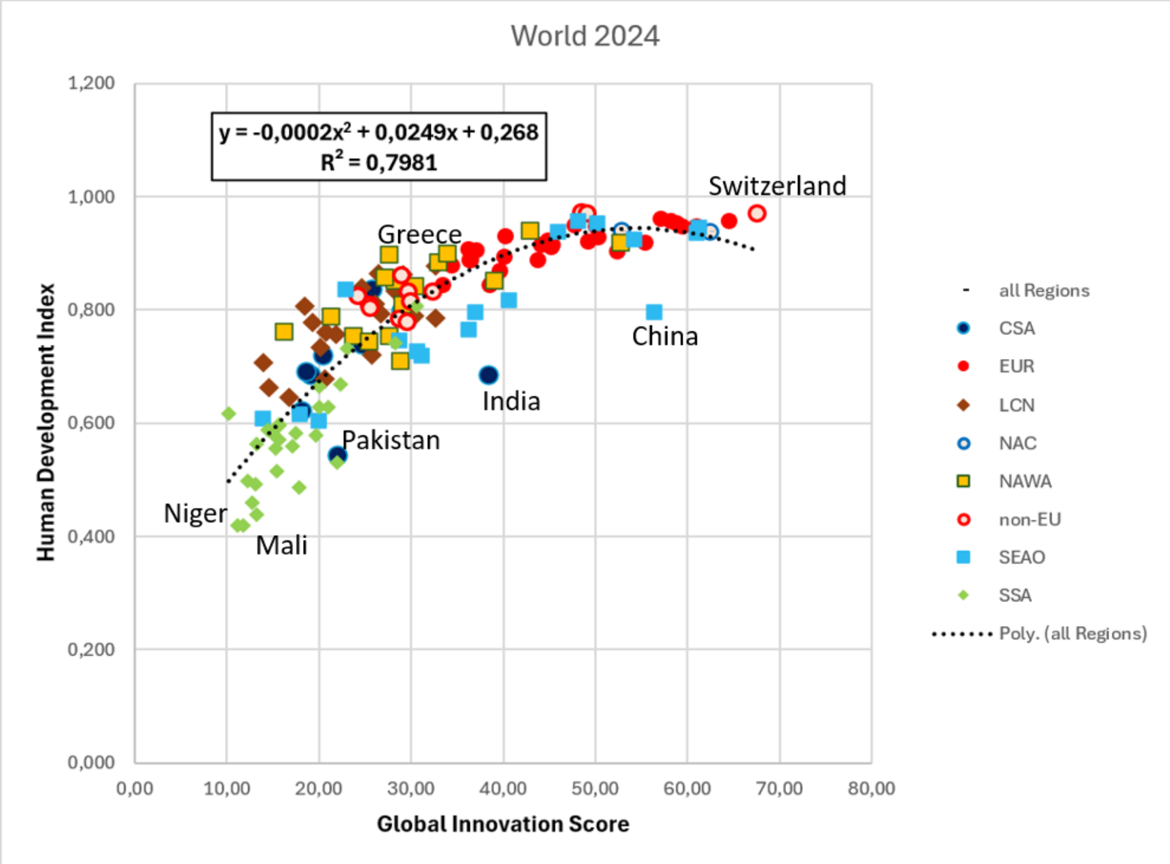

Figure 2. Human Development Index versus the Global Innovation Score of 131 countries from all around the globe

A quite good correlation of a polynomial fit is revealed as R2 receives the value of 0.7981 for the whole sample. The region of SSA lays at the low range of the curve while the most developed countries appear at the upper part of the curve, wherein a plateau is revealed. The correlation of HDI with GIS at each region in a linear regression is given in Table 4. The relevant graphs can be found in Appendix A of Figures.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.6407	0.7307	0.7945	0.4686	0.5101	0.0886	0.6462

Table 4. The R square of the correlation between HDI and Global Innovation Score for each region around the globe

As can be seen in Table 4, the HDI correlates quite well with GIS for almost all regions around the globe. On the contrary, the CSA region presents rather no correlation. This result for CSA is stemming from countries such as India which presents a relatively high innovation compared to the development of its society e.g. years of schooling, and Pakistan which has serious issues of gender discrimination reducing further the years of schooling within its population compared to its moderate innovation score. Most of the variance in Human Development data for CSA region is not explained by its innovative activities.
The welfare of society relates well with the happiness level of its citizens (O'Connor, 2017). The Happiness Report versus the Global Innovation Score (GIS) for 131 countries around the globe is depicted in Figure 3.

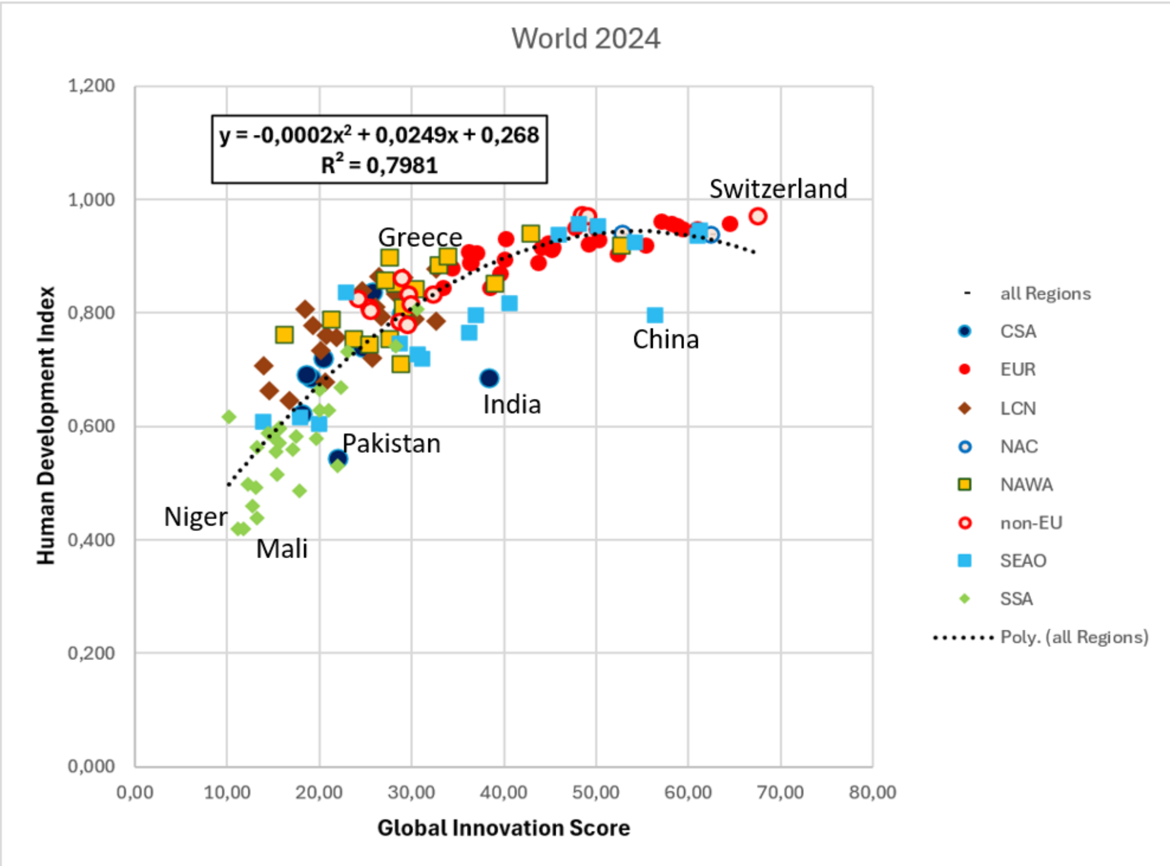

Figure 3. Happiness Report versus the Global Innovation Score of 131 countries from all around the globe

A fair linear correlation is revealed as R2 receives the value of 0.5093 for the whole sample. The region of SSA lays at the low range of the line while the most developed countries

appear at the upper part of the curve. Such a relationship could be explained with the Capability Approach developed by Sen among countries over the globe with different commodities on functioning (Sen, 1993). Advancements in innovation affects directly people's capabilities to function effectively providing opportunities and shaping wellbeing, in a similar way (slope) both for rich and poor countries.
The correlation of Happiness Report with GIS at each region in a linear regression is given in Table 5. The relevant graphs can be found in Appendix A of Figures.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.1761	0.4807	0.616	0.376	0.0912	0.0521	0.535

Table 5. The R square of the correlation between Happiness Report and Global Innovation Score for each region around the globe

As can be seen in Table 5, the Happiness Report has a low correlation with GIS for all regions around the globe. Specifically, for CSA and LCN regions the Happiness Report is not related to the innovation score of these regions. Subjective well-being capabilities are the key opportunities an individual enjoys pursuing to achieve happiness (Binder, 2013). For poor and underdeveloped countries, this latter is unfortunately a luxury for citizens and seldom occurs. Therefore, most of the variance in Happiness Report data for these regions is not explained by its innovative activities. Any improvement in the innovative potential of these countries does not produce an observable result in social care, healthy life, or perception of corruption for the bulk of the population. Characteristic example appears to be India in the CSA region wherein its population faces economic inequality, poor living conditions and problematic health care as well high perception of corruption, although the country presents high innovative score. Similarly, Botswana is a characteristic example in the SSA region wherein the economic inequalities, the high unemployment and the low trust to institutions for its citizens drive the country at a low HR ranking in the group, although it presents a relevant high innovative score (see Appendix A). Note that Botswana belongs to the countries with high GDP per capita compared to its innovative potential due to the exploitation of its vast diamond reserves.

Researchers have identified a positive relation between labor welfare and job satisfaction (Srivastava, 2004). A satisfied worker feels joy and fulfillment and adds on social welfare. Analyzing data on job satisfaction from interviews of a sample of 26.354 citizens gathered from all European Union member states, valuable information has been extracted. Each country has a different opinion on job satisfaction, which is depicted in Figure 4 versus the respective GIS.

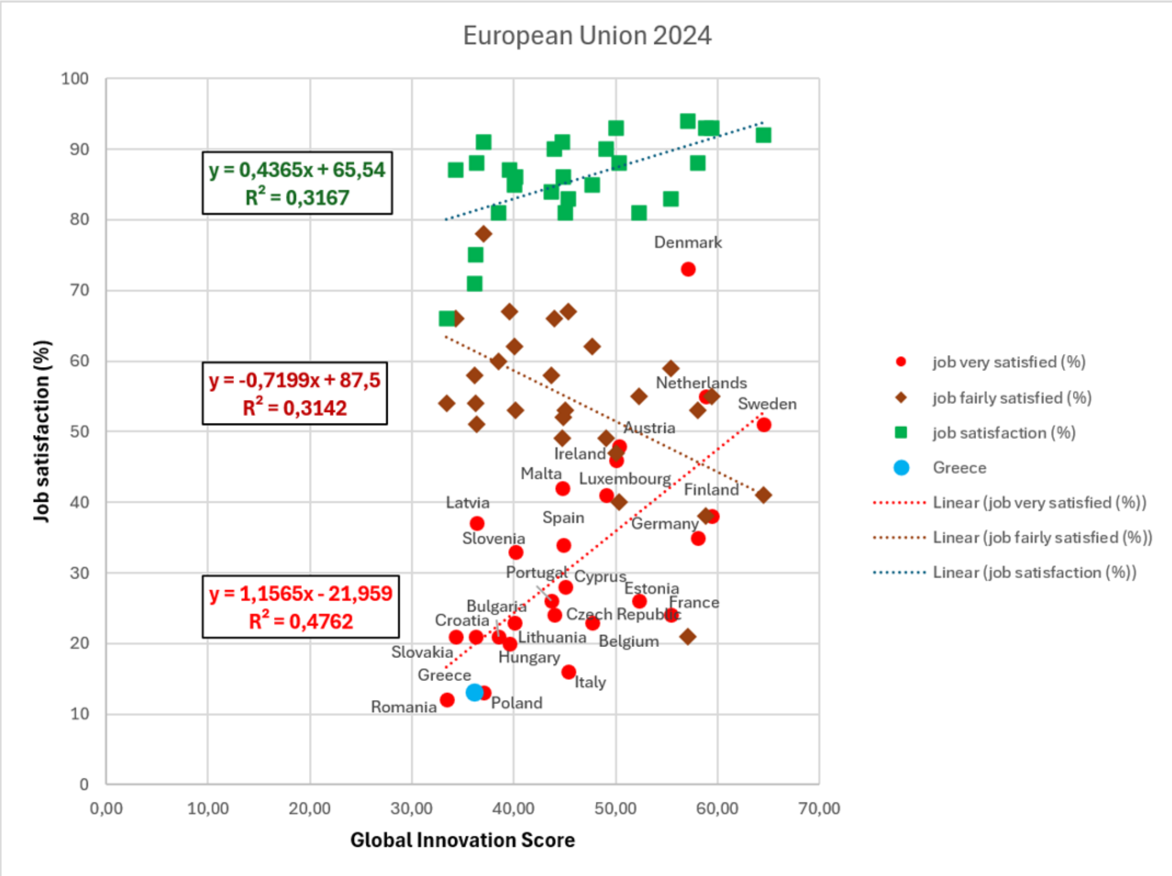

Figure 4. Job satisfaction versus Global Innovation Score for the 27 European Union countries

As shown in Figure 4, the advancement in innovation scores affects positively the workers (green line), increasing their job satisfaction. This score is the addition of data from "fairly satisfied" and "very satisfied" workers. Drawing individually these results, the correlation of the "very satisfied" workers with the respective innovation score of their country is positive than that of the "fairly satisfied" workers, which shows a negative correlation (see

Figure 4). It seems that the former workers are likely responsible for the technical advancement of their country and the productivity growth, which will be induced.

Instead of using the Global Innovation Score parameter, a similar analysis can be performed with the Global Innovation Index. Note that countries with the same score possess by this representation a different position on the board as they are assigned with another distinctive number/index. Additionally, GII is descending for the most innovative countries and receives the value of one for the most innovative country as opposed to GIS depiction which is increasing with innovation. The GII exploitation is shortly presented in the following graphs. The GDP per capita versus the Global Innovation Index for 131 countries around the globe is depicted in Figure 5.

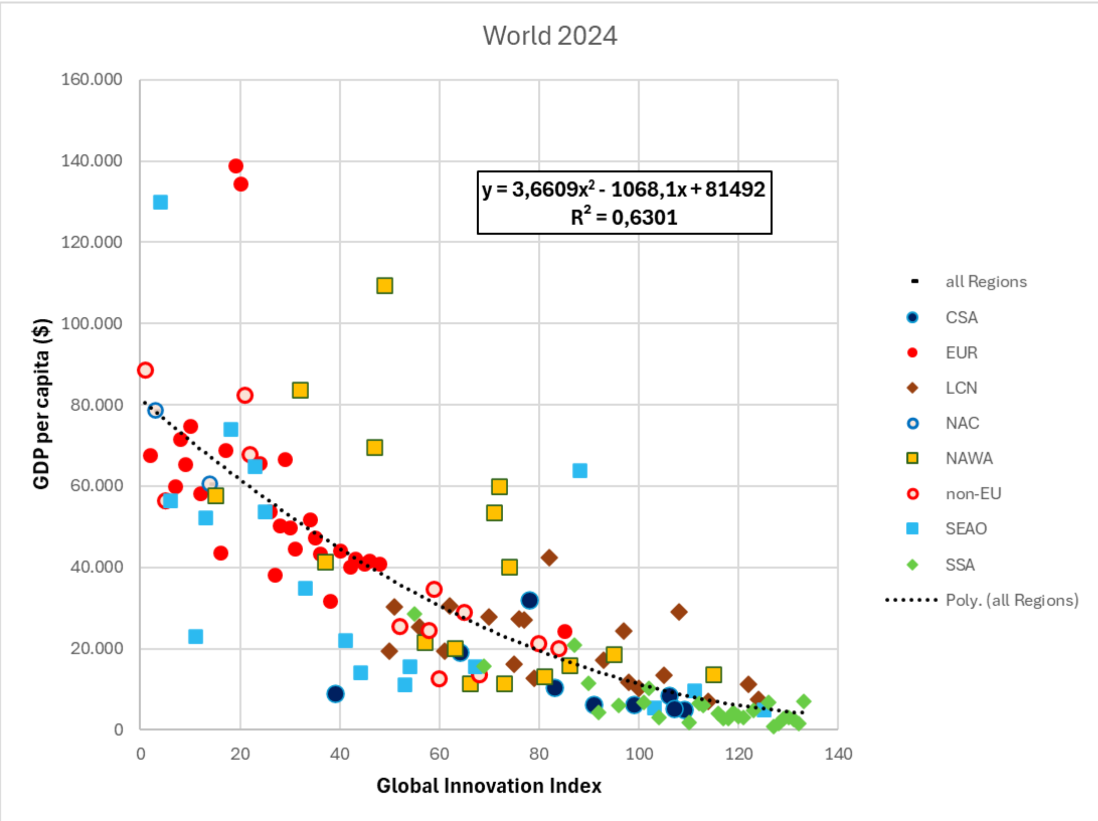

Figure 5. The GDP per capita versus the Global Innovation Index of the 131 countries from all around the globe

It is interesting to note the polynomial fitting model, wherein the poor countries (e.g. SSA) must put a lot of effort into innovation before their citizens realize significant increase on their related GDP per capita. Besides, the developed countries (e.g. EUR) realize higher

GDP per capita with marginal innovation advancements. It seems that in the latter case, the technical change occurring is more efficient for productivity growth.

The Human Development Index versus the Global Innovation Index of the 131 countries from all around the globe is presented in Figure 6.

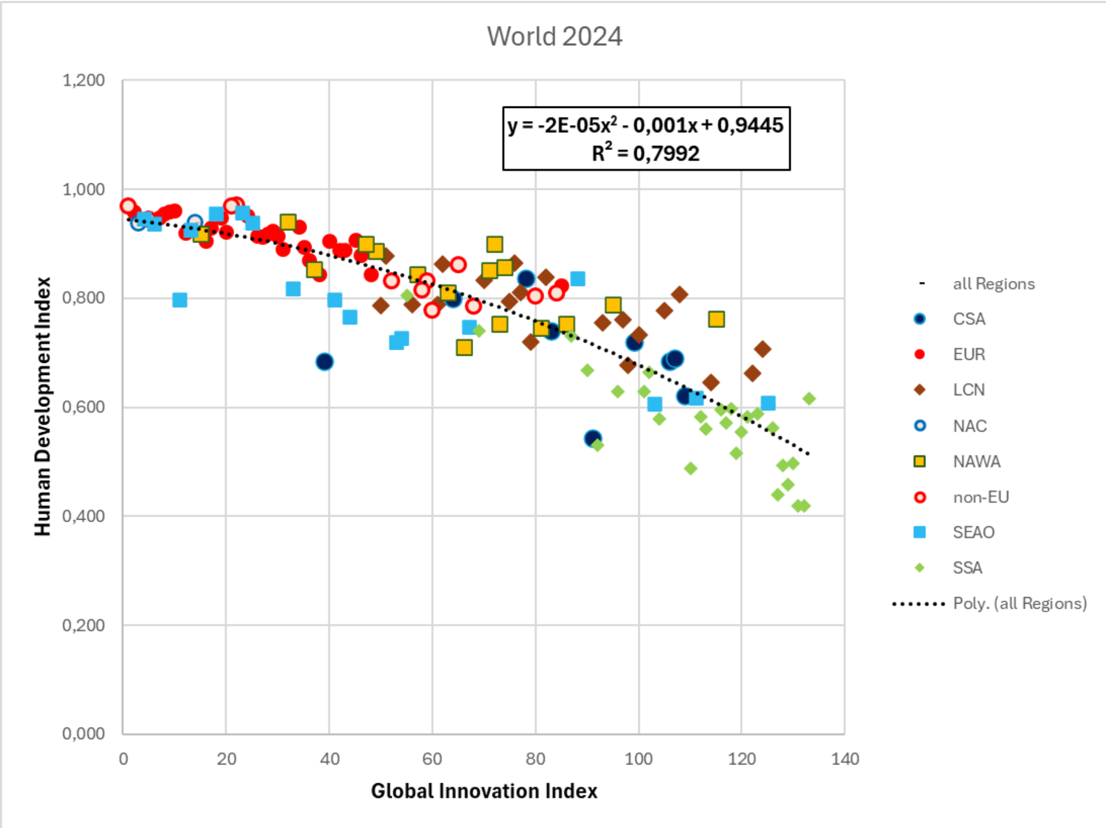

Figure 6. Human Development Index versus the Global Innovation Index of the 131 countries from all around the globe

As shown in Figure 6, the innovation level of a country has a notable effect on the Human Development Index especially for the poor countries compared to its limited effect on the developed world.

The Happiness Report versus the Global Innovation Index of the 131 countries from all around the globe is shown in Figure 7.

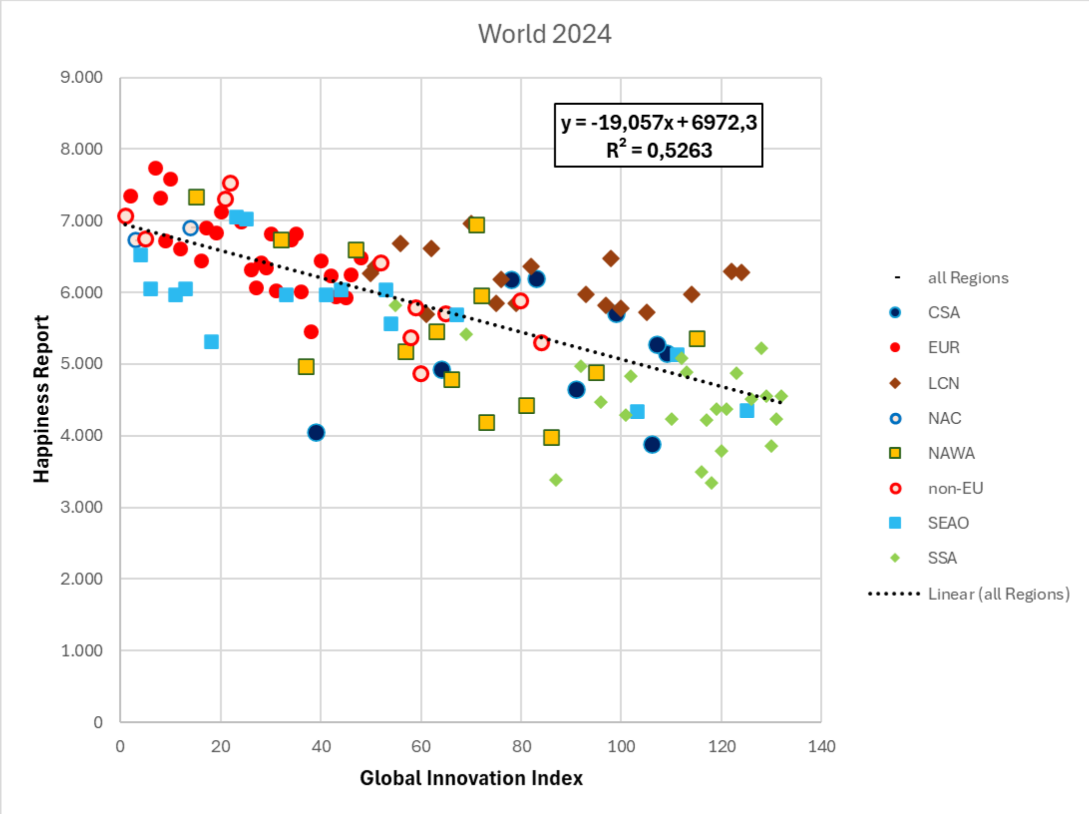

Figure 7. Happiness Report versus the Global Innovation Index of the 131 countries from all around the globe

Although, one could hardly detect correlation of innovation with happiness in specific regions around the world (e.g. LCN in Appendix A), seeing over the globe, however, a linear relationship between these parameters is found (Figure 7).

The Job satisfaction versus Global Innovation Index for the 27 European Union countries is presented in Figure 8.

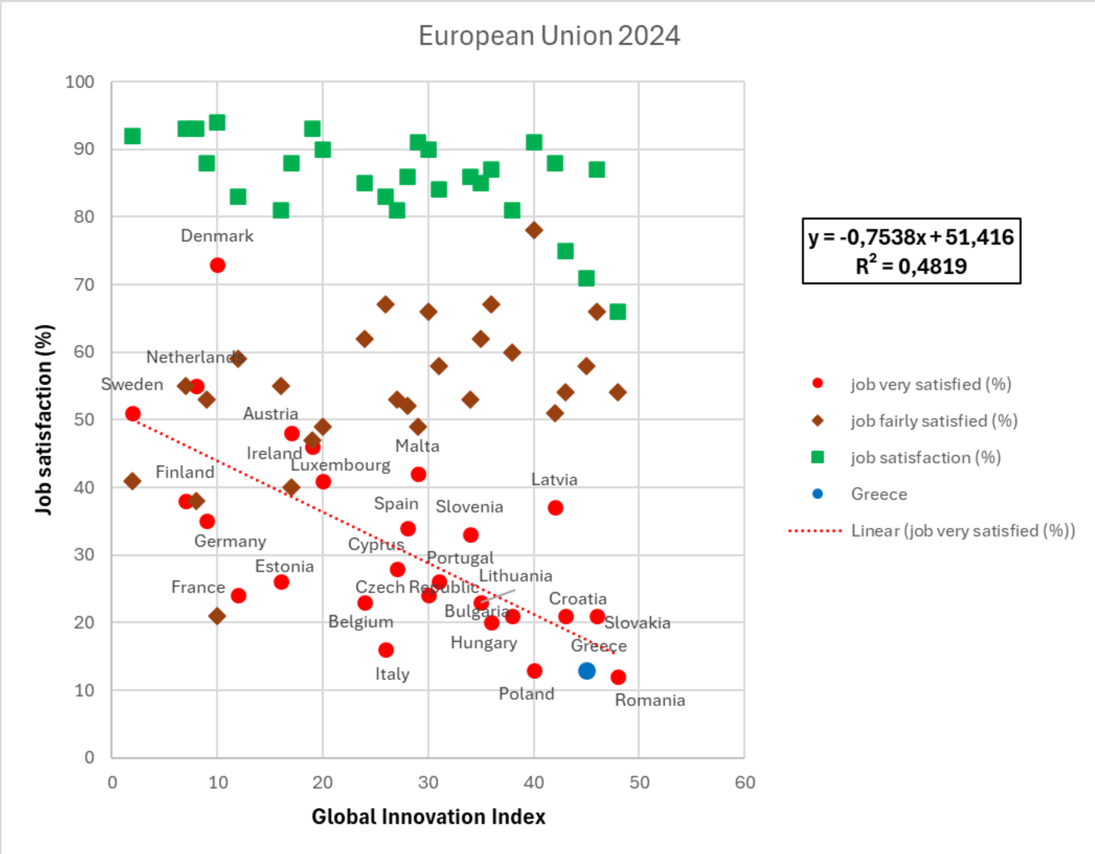

Figure 8. Job satisfaction versus Global Innovation Index for the 27 European Union countries

As shown in Figure 8, the increase in innovation level affects solely the "very satisfied" workers and their wellbeing, who are likely responsible for the technical advancement of their country and the induced productivity growth, which will take place. Interesting to note is the very low position of Greece at the category of "very satisfied" employees.

Following, an analysis of the innovation index of patents per million capita (PCT per capita) is considered. Note that not all 131 countries have data available on the subject, thus the comparison will compile the data revealed by the World Intellectual Property Organization (WIPO).

The logarithmic plot of the GDP per capita versus the PCT per capita around the world is depicted in Figure 9.

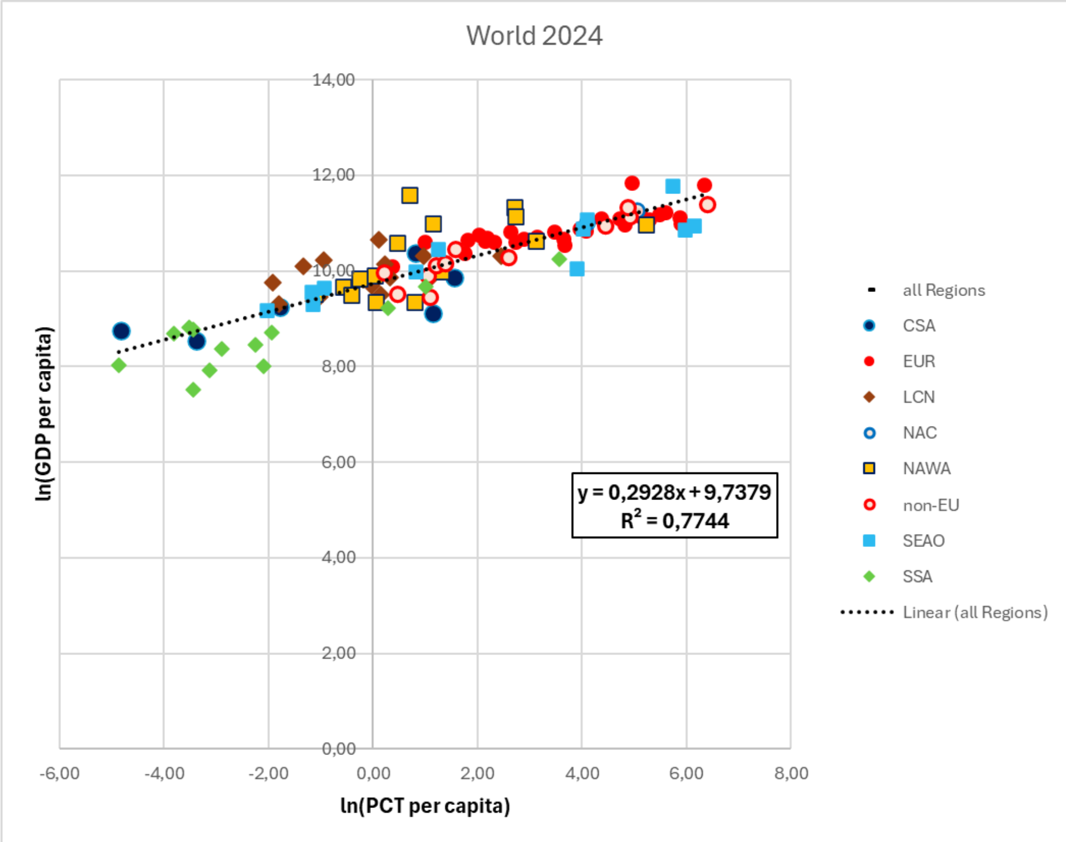

Figure 9. The log-log plot of the GDP per capita versus the PCT per capita of countries from all around the globe

As shown in Figure 9, the log-log plot presents linearity, indicating power law relation of these parameters as well as large ranges of data. In any case, the innovation recorded through patent applications affects the productivity and growth of a country. The strong positive correlation of patents with GDP has been recently presented for patent grants per million and GDP per capita (Gürler, 2022). The correlation of the log-log plot of the GDP per capita versus the PCT per capita at each region in a linear regression is given in Table 6. The relevant graphs can be found in Appendix A of Figures.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.6866	0.8088	0.8489	0.4128	0.2564	0.5716	0.6192

Table 6. The R square of the correlation between the log of the GDP per capita versus the log of the PCT per capita for each region around the globe

As can be seen in Table 6, the log of the GDP per capita has good correlation with the log of PCT per capita for almost all regions around the globe.

The log-log plot of the Human Development Index versus the PCT per capita around the world is presented in Figure10.

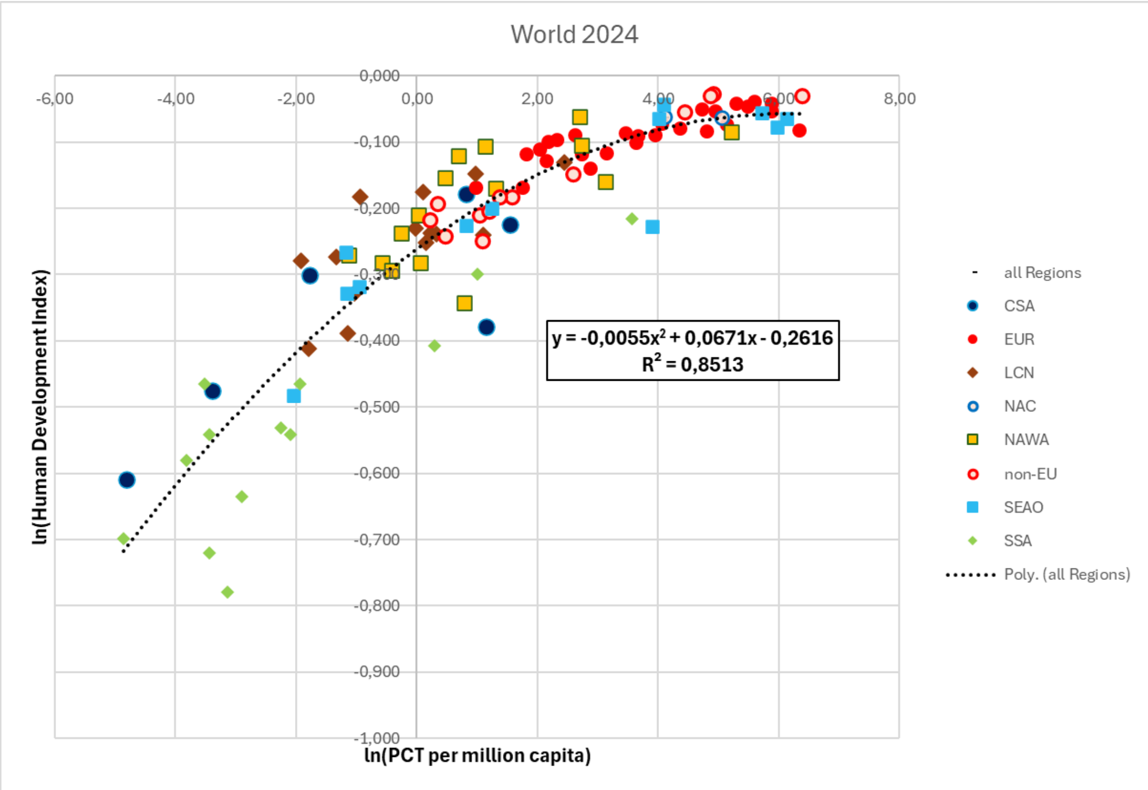

Figure 10. The log-log plot of the Human Development Index versus the PCT per capita of the countries from all around the globe

As shown in Figure 10, the log-log plot is fitted with a polynomial equation. It seems that the innovation recorded through patents affects the Human Development of a country, with greater effect on the least developed world.

The correlation of the log-log plot of the HDI versus the PCT per capita at each region in a linear regression is given in Table 7. The relevant graphs can be found in the Appendix.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.7266	0.8081	0.918	0.5121	0.5376	0.7152	0.7332

Table 7. The R square of the correlation between the log of HDI versus the log of the PCT per capita for each region around the globe

As can be seen in Table 7, the log of the HDI has good correlation with the log of PCT per capita for almost all regions around the globe.

The log-log plot of the Happiness Report versus the PCT per capita around the world is shown in Figure 11.

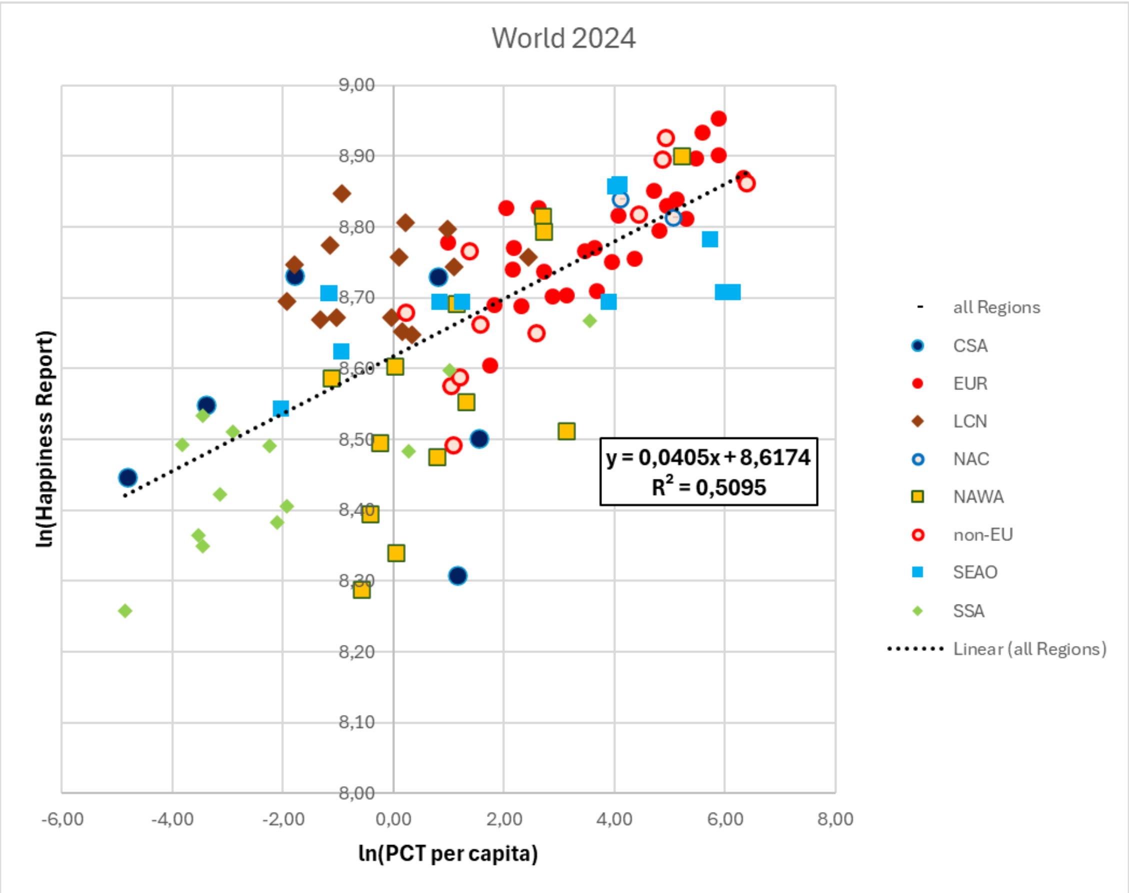

Figure 11. The log-log plot of the Happiness Report versus the PCT per capita of countries from all around the globe

As shown in Figure 11, the log-log plot of the Happiness Report versus the PCT per capita for the whole world indicates a moderate correlation.

The correlation of the log-log plot of the Happiness Report versus the PCT per capita at each region in a linear regression is given in Table 8. The relevant graphs can be found in Appendix A of Figures.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
R2	0.5741	0.363	0.6794	0.5461	0.0216	0.0008	0.5471

Table 8. The R square of the correlation between the log of Happiness Report versus the log of the PCT per capita for each region around the globe

As can be seen in Table 8, the log of the Happiness Report has moderate correlation with the log of PCT per capita for almost all regions around the globe. Specifically, for CSA and LCN regions the log Happiness Report is not related to the log of PCT per capita of these regions.

The log-log plot of the very satisfied workers versus the PCT per capita of the 27 European Union countries is depicted in Figure 12.

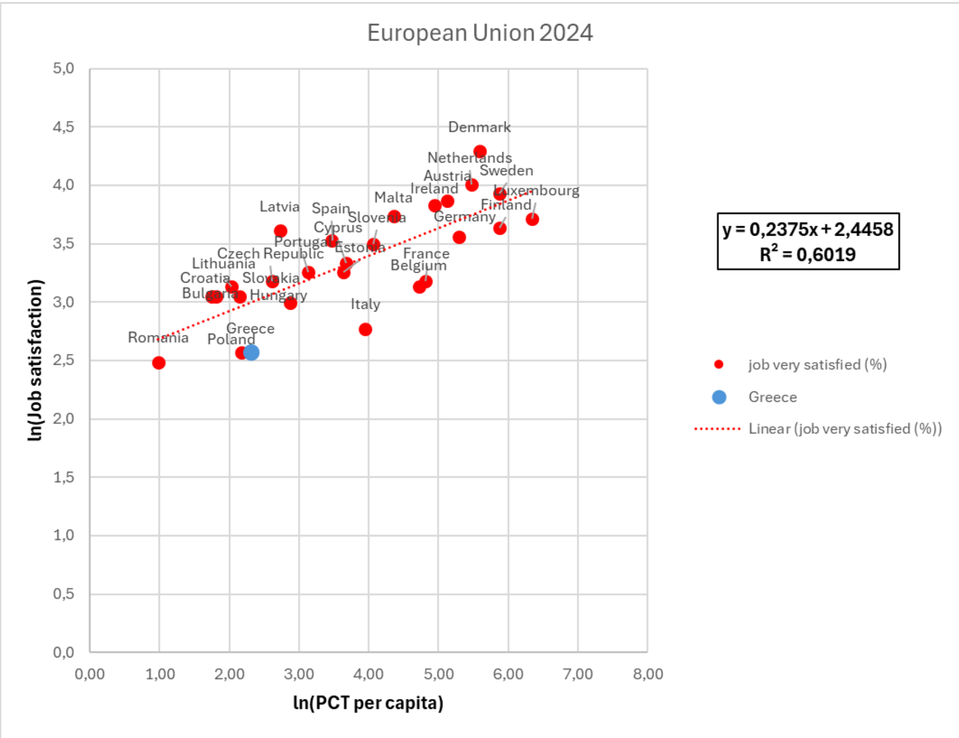

Figure 12. The log-log plot of the very satisfied workers versus the PCT per capita of the 27 European Union countries

As shown in Figure 12, the log-log plot presents a linear correlation supporting the idea that innovation advances wellbeing. At the lower part of the graph lays Romania, which has identified significant difficulties in the operation of its small medium enterprises (SMEs) and the relevant technology transfer (Stanciu, 2018). In case of Greece, the number of PCT per capita corresponds to a lower job satisfaction than expected for the "very satisfied" employees as compared to the European average. On the one hand, the innovation metric of PCT per capita positions Greece at a low European level and on the other hand, the achieved national innovation degree does not promote the wellbeing of the Greek employees as it would be anticipated.

4.2 Multiple regression analysis

For investigating the parameters that affect innovation, multiple regression is considered. Therefore, the Global Innovation Index (GII) is the dependent parameter, which is correlated with various independent factors.

For structuring this function, characteristics of the various indices and scores are examined. Basically, Human Development Index (HDI) stems by consolidating data of Life Expectancy at birth, Expected Years of Schooling and Gross National Income per capita. As these parameters are considered the cornerstone of society's development, HDI receives a major position in present multiple regression function. Moreover, innovation is expected to relate to the quality of research conducted within a community as well as to its ability to bring new ideas into business. Finally, the efficiency of the community in finances and start-ups should be also of crucial importance. Thus, the Global Innovation Score (GIS) is correlated with Human Development Index (HDI), Human Capital and Research Score (HCRS), Business Sophistication Score (BSS) and Credit Score (CS). Note that these specific data were available only for 120 countries from the initial sample of 131 countries around the globe. Also, multiple regression could not run for the NAC region as it relates to only two countries, namely USA and Canada.

The summary output of above multiple regression for the globe is presented in Table 9, indicating great correlation (R2=0.95) and P-value<0.05.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,975353463							
R Square	0,951314378							
Adjusted R Square	0,949620965							
Standard Error	3,254467253							
Observations	120							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	4	23800,22085	5950,055213	561,7734161	1,86811E-74			
Residual	115	1218,029066	10,5915571					
Total	119	25018,24992						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-5,99457219	2,185795939	-2,742512273	0,007073551	-10,32421327	-1,66493111	-10,3242133	-1,66493111
Human Development Index	14,99038646	4,021606309	3,727462439	0,000301619	7,024358357	22,95641457	7,024358357	22,95641457
Human capital & Research Score	0,257490389	0,055496485	4,639760333	9,3061E-06	0,147562533	0,367418245	0,147562533	0,367418245
Business sophistication Score	0,479913176	0,041503571	11,56317788	5,49964E-21	0,397702589	0,562123763	0,397702589	0,562123763
Credit score	0,081730806	0,021426701	3,814437274	0,00022123	0,039288635	0,124172976	0,039288635	0,124172976

Table 9. Multiple regression of GIS with HDI, HCRS, BSS and CS for 120 countries around the globe

Apart from the overall model performance, diagnostics are run to investigate multicollinearity and the presence of heteroscedasticity. As shown in Table 10, VIF is below the value of 5, supporting the idea that the results are not biased. However, only Human capital & research score is higher than the rest of the variables and closer to 5 indicating moderate multicollinearity. Moreover, the residual plots are scattered randomly and rather equally around the horizontal line without any visible pattern (relevant figures are shown in the Appendix A of Figures).

Independent variable / predictor	**R2**	**VIF**
Human development index	0.732	2.16
Human capital & research score	0.876	4.30
Business sophistication score	0.790	2.66
Credit score	0.493	1.32

Table 10. Investigating multicollinearity of the variables HDI, HCRS, BSS and CS for 120 countries around the globe

Going a step further, above multiple regression is run for every and each region around the globe. The correlation of the Global Innovation Score (GIS) with Human Development Index (HDI), Human Capital and Research Score (HCRS), Business Sophistication Score

(BSS) and Credit Score (CS) is given in Table 10. The relevant regressions of each region can be found in the Appendix B of Tables.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
Adjusted R2	0.7576	0.9616	0.9733	0.8583	0.7930	0.1545	0.9191

Table 11. The Adjusted R square of the correlation between Global Innovation Score (GIS) and Human Development Index (HDI), Human Capital and Research Score (HCRS), Business Sophistication Score (BSS) and Credit Score (CS) for each region around the globe

Comparing the adjusted R2 of Table 11, it appears that innovation is affected differently by the same parameters for the different countries around the globe. Especially, SSA and CSA regions have the lowest adjusted R square, 0.75 and 0.15, respectively. Major role in this discrepancy should be the lack of basic infrastructure which affects the way that poor countries react to technology spillover effects.

Therefore, the multiple regression of innovation is re-examined under different parameters. More specifically, the Global Innovation Score (GIS) is correlated with Human Development Index (HDI), Information and Communication Technology Score (ICTS), Human Capital and Research Score (HCRS). The summary output of above multiple regression for the globe is presented in Table 11, indicating a fair correlation (R2=0.89).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,945869167
R Square	0,894668481
Adjusted R Square	0,89194439
Standard Error	4,766270016
Observations	120

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	22383,03965	7461,013218	328,4282643	1,66575E-56
Residual	116	2635,210264	22,71732986		
Total	119	25018,24992			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,595214684	3,6745689	0,161982181	0,871601697	-6,682732028	7,873161395	-6,682732	7,873161395
Human Development Index	-4,71688513	8,490075921	-0,555576319	0,57957045	-21,53255026	12,09878	-21,53255	12,09878
ICTs score	0,159259618	0,048055921	3,314047773	0,001227266	0,064078811	0,254440425	0,0640788	0,254440425
Human capital & Research Score	0,741967521	0,05566431	13,32932218	3,78584E-25	0,631717341	0,852217701	0,6317173	0,852217701

Table 12. Multiple regression of GIS with HDI, ICTS and HCRS for 120 countries around the globe

Apart from the overall model performance, multicollinearity and heteroscedasticity are examined. As shown in Table 13, VIF is below the value of 5, supporting the idea that the results are not biased. However, only Human development index is higher than the rest of the variables and closer to 5 indicating moderate multicollinearity. Moreover, the residual plots are scattered randomly and rather equally on both sides of the line without any visible pattern (relevant figures are shown in the Appendix A of Figures).

Independent variable / predictor	**R2**	**VIF**
Human development index	0.871	4.15
Information and communication technology score	0.830	3.22
Human capital and research score	0.763	2.18

Table 13. Investigating multicollinearity of the variables HDI, ICTS and HCRS for 120 countries around the globe

Below, the same function runs for each region. The regional correlation of the Global Innovation Score (GIS) with Human Development Index (HDI), Information and Communication Technology Score (ICTS), Human Capital and Research Score (HCRS) is given in Table 14. The relevant regressions of each region can be found in the Appendix B of Tables.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
Adjusted R2	0.8586	0.9496	0.9020	0.7402	0.7864	-0.623	0.7656

Table 14. The Adjusted R square of the correlation between Global Innovation Score (GIS) and Human Development Index (HDI), Information and Communication Technology Score (ICTS), Human Capital and Research Score (HCRS) for each region around the globe

Comparing the adjusted R2 of Table 14, it appears that SSA region has improved significantly its adjusted R square at 0.85, however the innovation within CSA region lacks correlation with these indices. Additionally, other regions with higher GII like EUR depicted lower correlation with current function. It is speculated that for the least developed countries within the CSA region, the observed discrepancy relates to reasons like poor institutional and regulatory environment.

For constructing another more suitable function, it is considered that for all countries it would be crucial the way that investments are capitalized. Therefore, the Global Innovation Score (GIS) is now correlated with Human Development Index (HDI), Institutions Score (IS) and Market Sophistication Score (MSS). The summary output of above multiple regression for the globe is presented in Table 15, indicating a nice correlation (R2=0.89).

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,945197595							
R Square	0,893398493							
Adjusted R Square	0,890641558							
Standard Error	4,794917515							
Observations	120							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	22351,26678	7450,422259	324,0549101	3,33577E-56			
Residual	116	2666,983141	22,99123397					
Total	119	25018,24992						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-17,10303338	2,725993759	-6,274054487	6,26515E-09	-22,5022075	-11,7038593	-22,5022075	-11,70385925
Human Development Index	30,84333923	4,956257597	6,223110609	7,99564E-09	21,02684656	40,6598319	21,02684656	40,6598319
Institutions Score	0,229894266	0,033031426	6,959865045	2,16739E-10	0,164471365	0,295317167	0,164471365	0,295317167
Market sophistication Score	0,394678351	0,040695403	9,698352168	1,20699E-16	0,314075978	0,475280725	0,314075978	0,475280725

Table 15. Multiple regression of GIS with HDI, IS and MSS for 120 countries around the globe

Apart from the overall model performance, multicollinearity and heteroscedasticity are examined. As shown in Table 16, VIF is below the value of 5, supporting the idea that the results are not biased.

Moreover, the residual plots are scattered randomly and rather equally on both sides of the line without any visible pattern (relevant figures are shown in the Appendix A of Figures).

Independent variable / predictor	**R2**	**VIF**
Human development index	0.618	1.61
Institutions score	0.558	1.45
Market sophistication score	0.545	1.42

Table 16. Investigating multicollinearity of the variables HDI, IS and MSS for 120 countries around the globe

Above multiple regression is run further for every and each region around the globe. The correlation of the Global Innovation Score (GIS) with Human Development Index (HDI), Institutions Score (IS) and Market Sophistication Score (MSS) is given in Table 17. The relevant regressions of each region can be found in the Appendix B of Tables.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
Adjusted R2	0.8795	0.8199	0.8676	0.8202	0.6643	0.7598	0.8992

Table 17. The Adjusted R square of the correlation between Global Innovation Score (GIS) and Human Development Index (HDI), Institutions Score (IS) and Market Sophistication Score (MSS) for each region around the globe

Comparing the adjusted R2 of Table 17, it appears that LCN, CSA and SSA regions have improved significantly their adjusted R square at 0.66, 0.75 and 0.87, respectively. Additionally, other regions with higher GII like EUR depicted a fair correlation with current function. However, regions with anticipated potential to innovate like SEAO, NAWA or non-EU presented moderate correlation under this function. It is speculated that for such regions, the observed discrepancy relates to reasons like credit, knowledge workers and innovation linkages.

Therefore, the multiple regression of innovation is examined again under different parameters. More specifically, the Global Innovation Score (GIS) is correlated with Human Development Index (HDI), Business Sophistication Score (BSS) and Credit Score (CS). The summary output of above multiple regression for the globe is presented in Table 18, indicating a great correlation (R2=0.94).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,970670229
R Square	0,942200693
Adjusted R Square	0,940705884
Standard Error	3,530699718
Observations	120

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	23572,21242	7857,40414	630,3148304	1,30548E-71
Residual	116	1446,037498	12,4658405		
Total	119	25018,24992			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-10,68250571	2,102769599	-5,080207417	1,45664E-06	-14,84730586	-6,51770557	-14,84730586	-6,51771
Human Development Index	25,7551064	3,563694612	7,227080095	5,63636E-11	18,69676018	32,81345261	18,69676018	32,81345
Business sophistication Score	0,602333804	0,034756278	17,33021613	5,61142E-34	0,533494617	0,671172991	0,533494617	0,671173
Credit score	0,112286022	0,022120192	5,076177509	1,48212E-06	0,068474195	0,15609785	0,068474195	0,156098

Table 18. Multiple regression of GIS with HDI, BSS and CS for 120 countries around the globe

Apart from the overall model performance, multicollinearity and heteroscedasticity are examined. As shown in Table 19, VIF is below the value of 5, supporting the idea that the results are not biased. Moreover, the residual plots are scattered randomly and rather equally on both sides of the line without any visible pattern (relevant figures are shown in the Appendix A of Figures).

Independent variable / predictor	**R2**	**VIF**
Human development index	0.599	1.56
Business sophistication score	0.648	1.72
Credit score	0.441	1.24

Table 19. Investigating multicollinearity of the variables HDI, BSS and CS for 120 countries around the globe

Above multiple regression is run further for every and each region around the globe. The correlation of the Global Innovation Score (GIS) with Human Development Index (HDI), Business Sophistication Score (BSS) and Credit Score (CS) is given in Table 20. The relevant regressions of each region can be found in the Appendix B of Tables.

	SSA	SEAO	non-EU	NAWA	LCN	CSA	EUR
Adjusted R2	0.7586	0.9591	0.9652	0.8711	0.8028	0.2010	0.9223

Table 20. The Adjusted R square of the correlation between Global Innovation Score (GIS) and Human Development Index (HDI), Business Sophistication Score (BSS) and Credit Score (CS) for each region around the globe

Comparing the adjusted R2 of Tables 20, it appears that SEAO, non-EU and NAWA regions have improved their adjusted R square at 0.95, 0.96 and 0.87, respectively. Additionally, other regions with higher GII like EUR depicted an excellent correlation with current function reporting adjusted R square of 0.92 and P-value<0.05. Besides, SSA and LCN regions depict fair correlation while CSA presented the lowest correlation with an R square value of 0.50 (see Appendix B of Tables).

5. Discussion

The comparison of the consolidated data of the countries around the globe for proving the relationship of innovation with social welfare indices, presents a fair correlation, which underlines the high degree that these parameters are interconnected. As shown in Figure 13, the welfare indices of GPD per capital, HDI and HR, present high R2, thus they are explained sufficiently by the innovation indices of GII, GIS or PCT per capita. However, social welfare as expressed by HDI presents the highest correlation to innovation. This might relate inherently with the composite metric of HDI wherein its components are well structured to fit the level of innovation in both developed and developing countries. Note that the comparison on the variance of the welfare indices is studied on the same innovation parameter, as any comparison between linear and log-log scale is misleading due to the different types of variability.

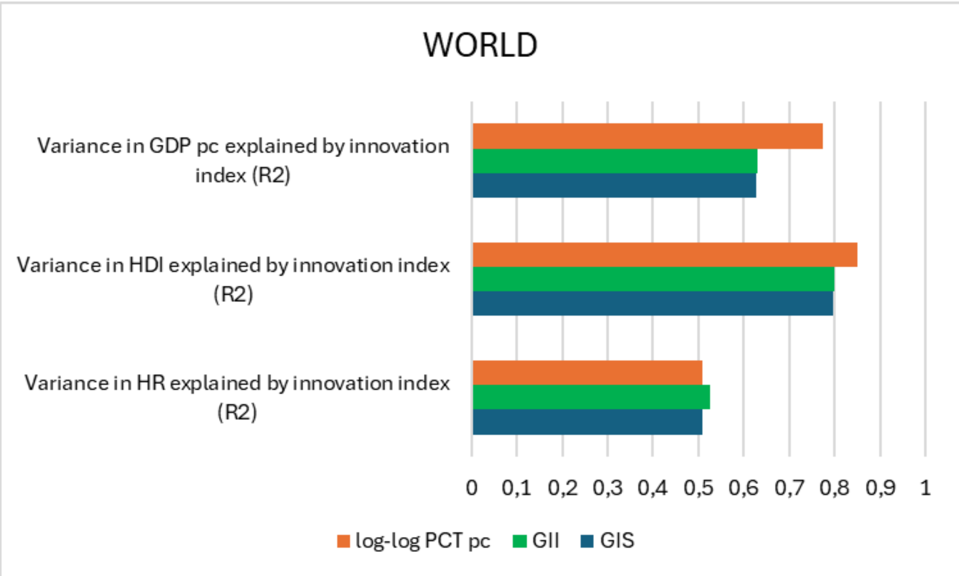

Figure 13. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for the sum of the countries

The suitable selection of the predictors for modeling the global innovation growth as this is expressed by the GIS, is depicted in Figure 14.

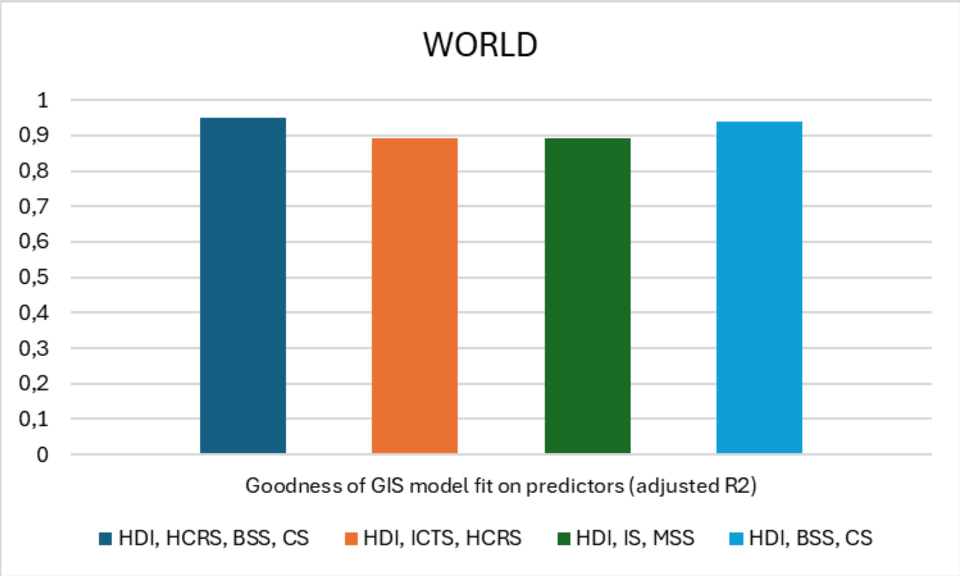

Figure 14. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for the sum of the countries

As presented in Figure 14, the bundle of factors that best predict global innovation relates to the combination of HDI, HCRS, BSS and CS, with an adjusted R2 value of 0.9496. This implies that the global innovative potential is enhanced by driving governmental policies into improving parameters such as the years of schooling, spendings in education, number of researchers, quality of universities, expenditures on R&D, knowledge workers, innovation linkages, knowledge absorption and finance on firms. In other words, an efficient national innovation system along with enlarged capabilities of society through endogenous growth produces innovation. Note that this combination of variables presents p-values less than 0.05 (see Table 9) indicating that the observed results are statistically significant. The relevant equation of the model is expressed as follows:

$$GIS\ (WORLD) = -5.99 + 14.99*HDI + 0.25*HCRS + 0.47*BSS + 0.08*CS \qquad (1)$$

As shown in equation (1), focusing on the most effective parameter, GIS will increase on average by 1.499 units for each 0.1 increase in HDI, net of the effects of changes due to HCRS, BSS and CS. Correlating innovation with welfare parameters reveals plurality of outcomes for the different regions around the globe. For that reason, the discussion continues focusing on regional level. Figure 15 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for SSA region.

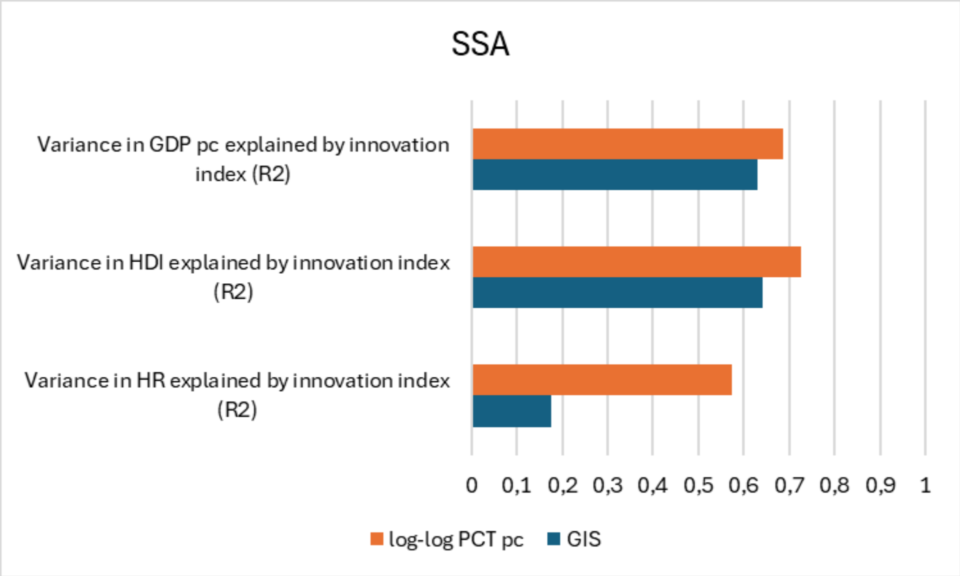

Figure 15. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for SSA

As shown in Figure 15, social welfare as expressed by HDI presents the highest correlation to innovation while HR shows the smallest one.

The suitable selection of the predictors for modeling the innovation growth in SSA as this is expressed by the GIS, is depicted in Figure 16.

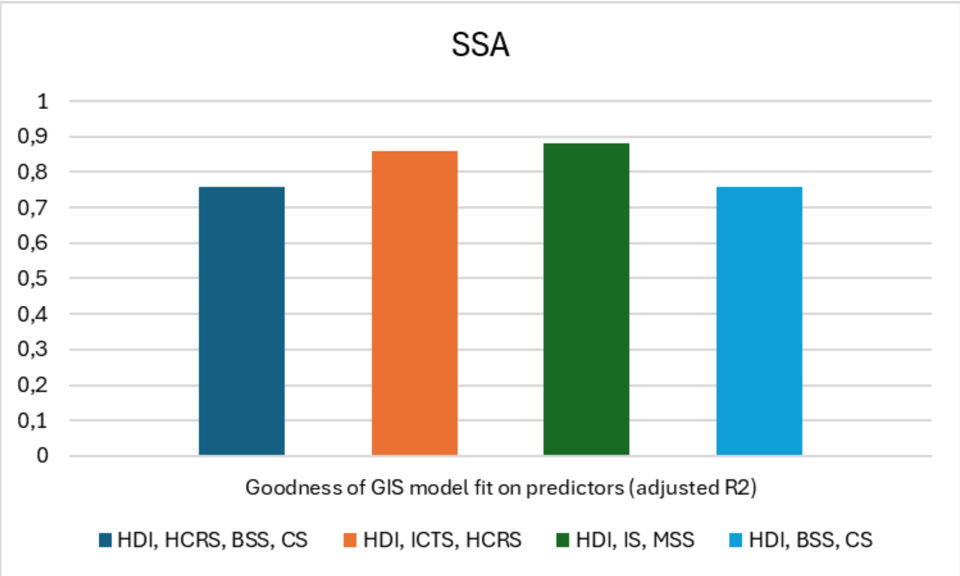

Figure 16. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for SSA

As presented in Figure 16, the bundle of factors that best predict innovation in SSA relates to the combination of HDI, IS, and MSS, with an adjusted R2 value of 0.8795. However, the selected combination is directed at HDI, ICTS and HCRS since only this combination of variables presents p-values less than 0.05 (see Appendix: Table 8) indicating that the observed results are statistically significant. The relevant equation of the model is expressed as follows:

$$GIS\ (SSA) = -1.59 + 16.77*HDI + 0.14*ICTS + 0.22*HCRS \qquad (2)$$

As shown in equation (2), focusing on the most effective parameter, GIS will increase on average by 1.677 units for each 0.1 increase in HDI, net of the effects of changes due to ICTS and HCRS. Additionally, improvements in infrastructure and human capital advance the scoring on innovation in SSA.

Figure 17 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for SEAO region.

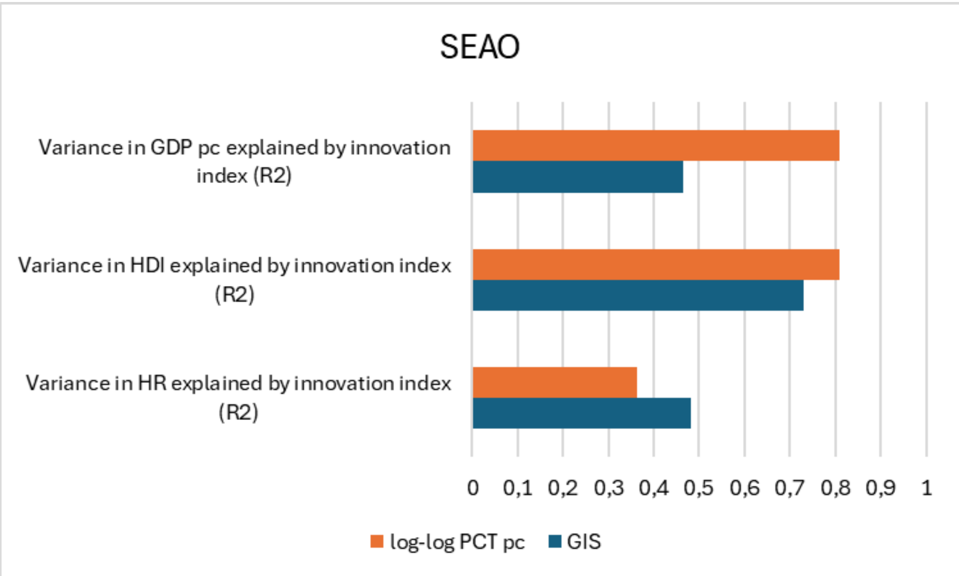

Figure 17. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for SEAO

As shown in Figure 17, social welfare as expressed by HDI presents again the highest correlation to innovation while HR shows the smallest one.

The suitable selection of the predictors for modeling the innovation growth in SEAO as this is expressed by the GIS, is depicted in Figure 18.

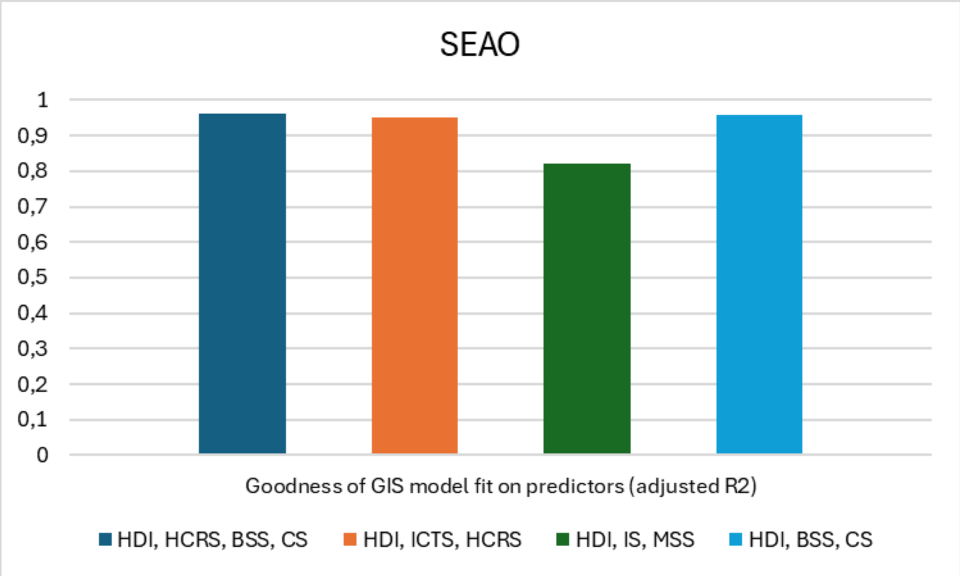

Figure 18. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for SEAO

As presented in Figure 18, the bundle of factors that best predict innovation in SEAO relates to the combination of HDI, HCRS, BSS, and CS, with an adjusted R2 value of 0.9616. However, the selected combination is directed at HDI, BSS and CS since only this combination of variables presents positive correlation of HDI with GIS (see Appendix: Table 23). The relevant equation of the model is expressed as follows:

$$\text{GIS (SEAO)} = -0.03 + 10.85*\text{HDI} + 0.70*\text{BSS} + 0.05*\text{CS} \qquad (3)$$

As shown in equation (3), focusing on the most effective parameter, GIS will increase on average by 1.085 units for each 0.1 increase in HDI, net of the effects of changes due to BSS and CS. Moreover, advancing knowledge workers, innovation linkages and credit seems to promote innovation scoring in SEAO.

Figure 19 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for non-EU region.

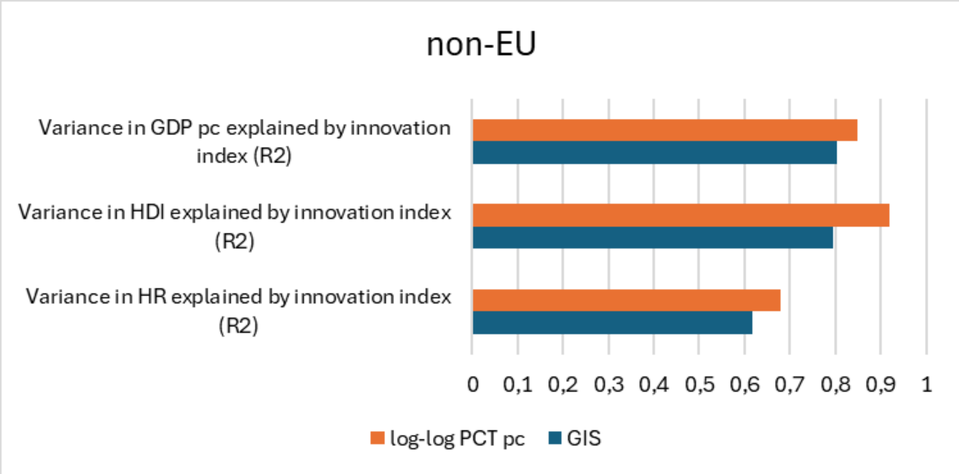

Figure 19. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for non-EU

As shown in Figure 19, social welfare as expressed by HDI and GDP per capita present rather similar correlation to innovation while HR lays at an acceptable level.
The suitable selection of the predictors for modeling the innovation growth in non-EU as this is expressed by the GIS, is depicted in Figure 20.

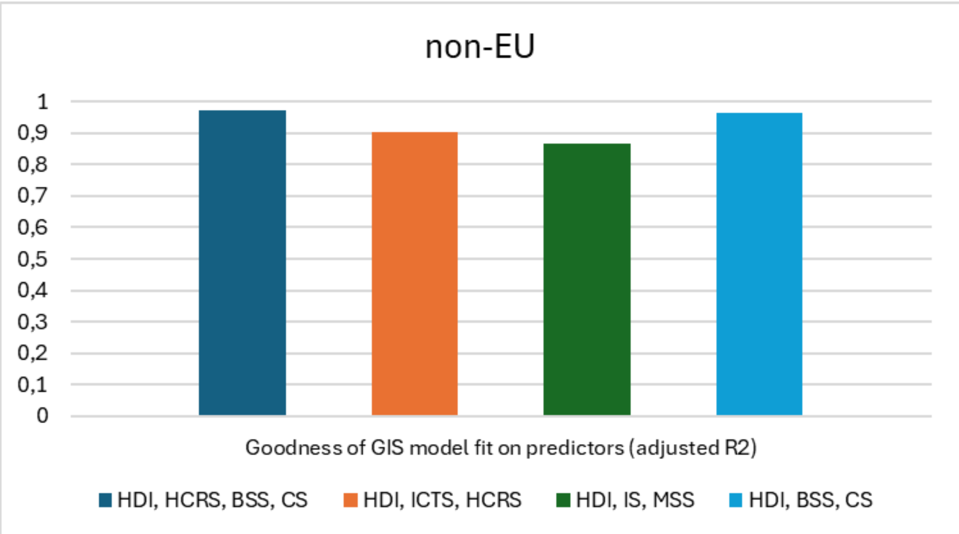

Figure 20. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for non-EU

As presented in Figure 20, the bundle of factors that best predict innovation in non-EU relates to the combination of HDI, HCRS, BSS, and CS, with an adjusted R2 value of

0.9733. However, the selected combination is directed at HDI, BSS and CS since this combination of variables presents positive correlation of HDI with GIS along with high adjusted R2 (see Appendix: Table 27). The relevant equation of the model is expressed as follows:

$$\text{GIS (non-EU)} = 3.23 + 1{,}89{*}\text{HDI} + 0.72{*}\text{BSS} + 0.19{*}\text{CS} \qquad (4)$$

As shown in equation (4), focusing on the most effective parameter, GIS will increase on average by 0.189 units for each 0.1 increase in HDI, net of the effects of changes due to BSS and CS. Moreover, business sophistication and sufficient credit for the market suggests higher innovation scores in the non-EU region.

Figure 21 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for NAWA region.

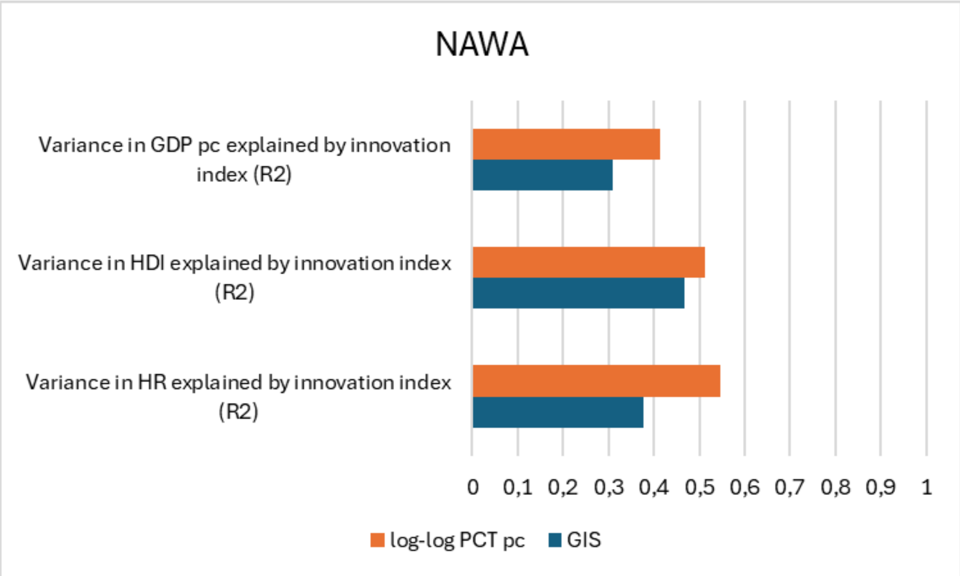

Figure 21. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for NAWA

As shown in Figure 21, social welfare as expressed by HDI presents the highest correlation to innovation while GDP per capita shows the smallest one. Note that the overall correlation of welfare with innovation for this region is rather moderate.

The suitable selection of the predictors for modeling the innovation growth in NAWA as this is expressed by the GIS, is depicted in Figure 22.

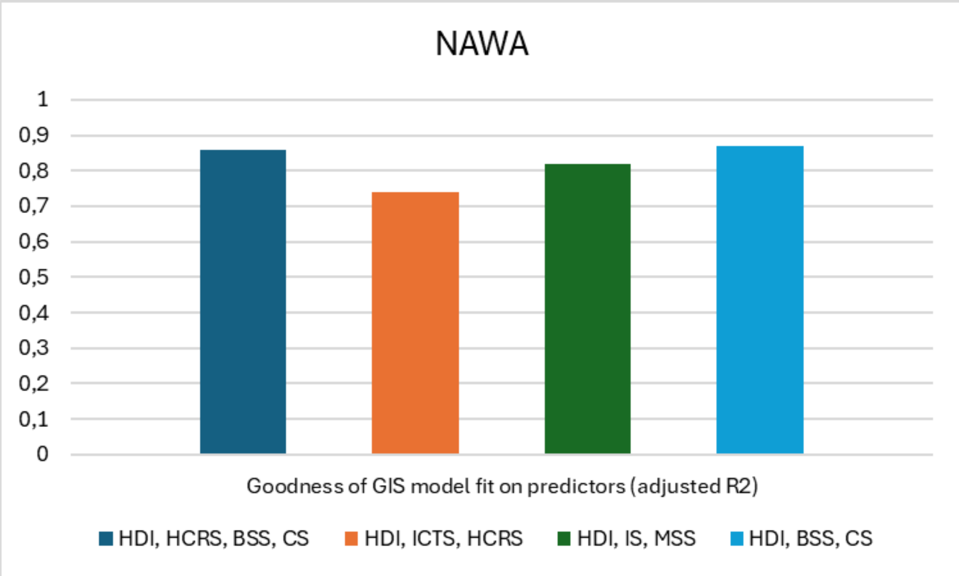

Figure 22. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for NAWA

As presented in Figure 22, the bundle of factors that best predict innovation in NAWA relates to the combination of HDI, BSS, and CS, with an adjusted R2 value of 0.8711. However, the selected combination is directed at HDI, IS and MSS because only this combination of variables presents positive correlation of HDI with GIS (see Appendix: Table 18). The relevant equation of the model is expressed as follows:

$$GIS\ (NAWA) = -9.53 + 29.62*HDI - 0.05*IS + 0.55*MSS \qquad (5)$$

As shown in equation (5), focusing on the most effective parameter, GIS will increase on average by 2.962 units for each 0.1 increase in HDI, net of the effects of changes due to IS and MSS. Nevertheless, above model contains some uncertainty as it pictures that innovation score in NAWA region is reducing by 0.05 when institution score is increasing by one unit, net of the effect of changes due to HDI and MSS.

Figure 23 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for LCN region.

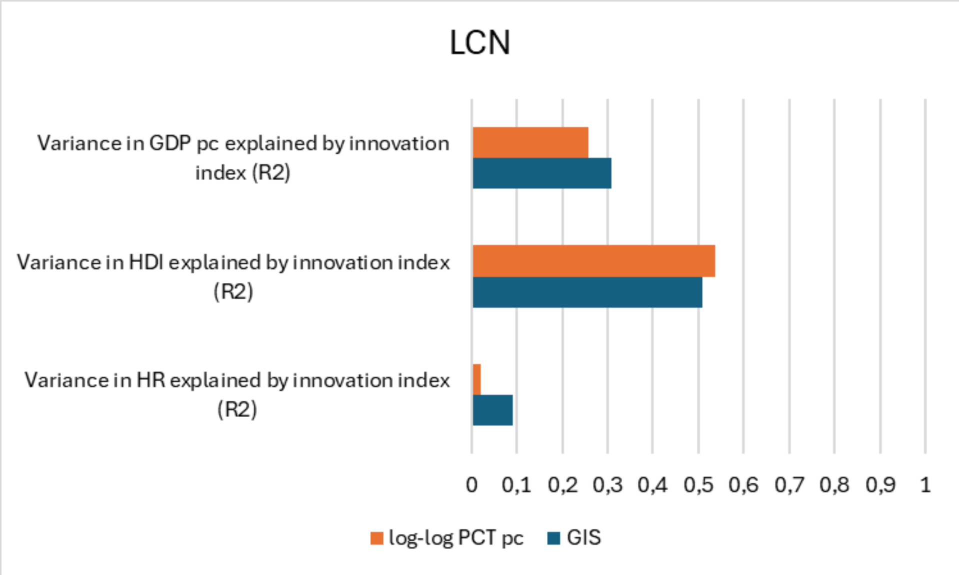

Figure 23. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for LCN

As shown in Figure 23, social welfare as expressed by HDI presents the highest correlation to innovation while HR shows the smallest one and close to zero.
The suitable selection of the predictors for modeling the innovation growth in LCN as this is expressed by the GIS, is depicted in Figure 24.

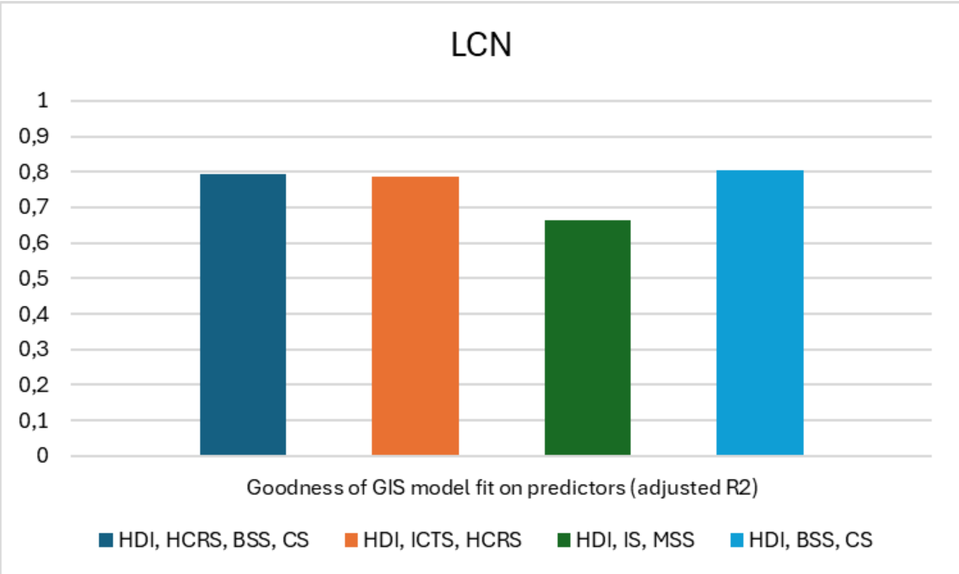

Figure 24. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for LCN

As presented in Figure 24, the bundle of factors that best predict innovation in LCN relates to the combination of HDI, BSS, and CS, with an adjusted R2 value of 0.8028. However, the selected combination is directed at HDI, IS and MSS since only this combination of variables presents p-values less than 0.05 (see Appendix: Table 19) indicating that the observed results are statistically significant. The relevant equation of the model is expressed as follows:

$$GIS\ (LCN) = -19.87 + 41.53*HDI + 0.16*IS + 0.21*MSS \qquad (6)$$

As shown in equation (6), focusing on the most effective parameter, GIS will increase on average by 4.153 units for each 0.1 increase in HDI, net of the effects of changes due to IS and MSS. It seems that for the Latin-American countries, the improvements in institutional and regulatory environment as well policy stability and market sophistication ameliorates innovation.
Figure 25 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for CSA region.

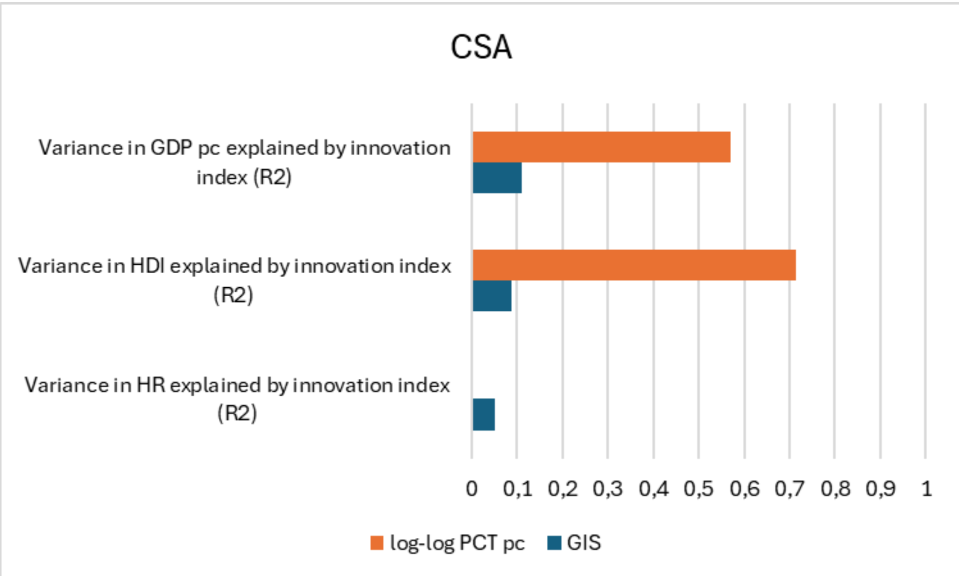

Figure 25. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for CSA

As shown in Figure 25, social welfare as expressed by HDI presents the highest correlation to innovation while HR shows the smallest one and close to zero.

The suitable selection of the predictors for modeling the innovation growth in CSA as this is expressed by the GIS, is depicted in Figure 26.

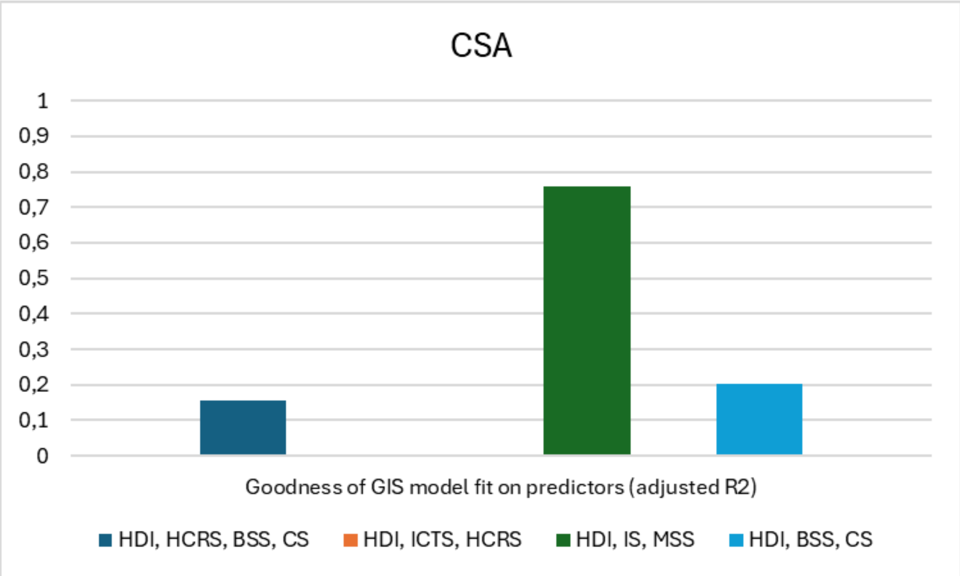

Figure 26. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for CSA

As presented in Figure 26, the bundle of factors that best predict innovation in CSA relates to the combination of HDI, IS, and MSS, with an adjusted R2 value of 0.7598. The relevant equation of the model is expressed as follows:

$$GIS\ (CSA) = 0.02 + 2.56*HDI + 0.24*IS + 0.43*MSS \qquad (7)$$

As shown in equation (7), focusing on the most effective parameter, GIS will increase on average by 0.256 units for each 0.1 increase in HDI, net of the effects of changes due to IS and MSS. Apparently for the central southern Asian countries, the quality in finance and venture capital investors as well as the refinement in institutions may progress innovation. Outliers in this region such as India, Pakistan or Bangladesh play significant role on correlation divergence. Interesting to note is the limited correlation between happiness and innovation degree. This phenomenon has been also observed for LCN and SSA, implying the existence of the Easterlin paradox wherein an increase of a country's economy does not induce a corresponding rise in happiness (Easterlin, 2009).
Figure 27 presents the proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for EUR region.

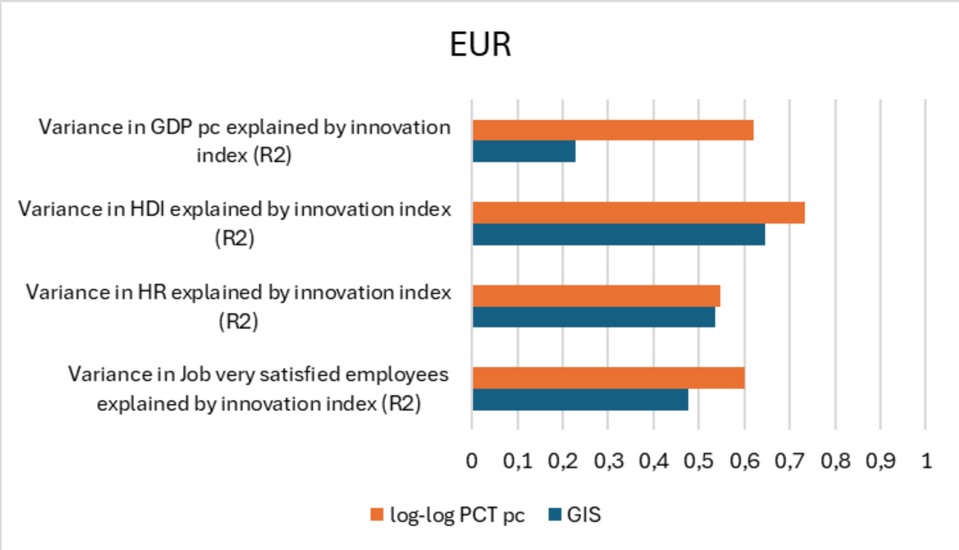

Figure 27. The proportion of variance of the welfare parameter that is explained by an innovation factor expressed by R2 coefficient of determination for EUR

As shown in Figure 27, social welfare as expressed by HDI presents the highest correlation to innovation while GDP shows rather the smallest one.

The suitable selection of the predictors for modeling the innovation growth in EUR as this is expressed by the GIS, is depicted in Figure 28.

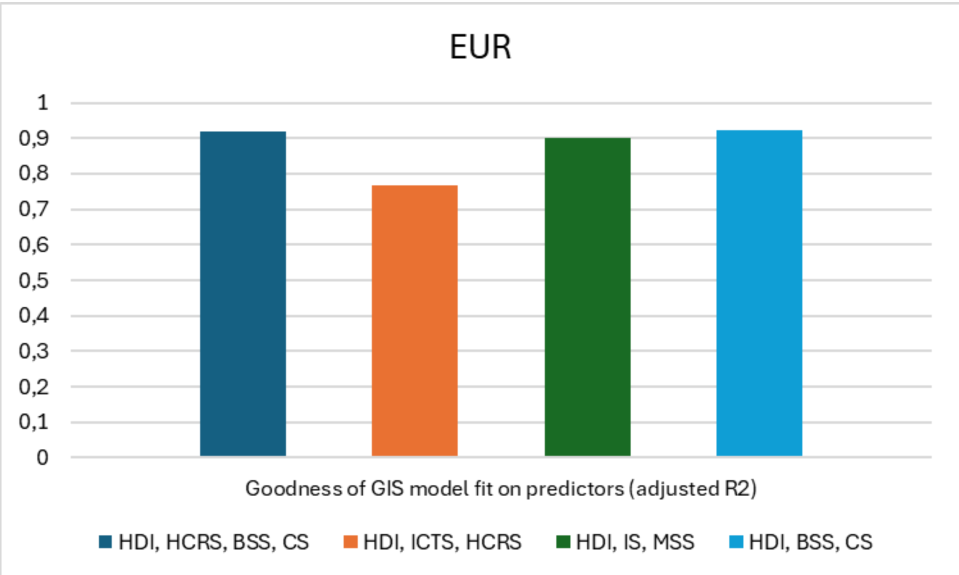

Figure 28. Goodness of fit of the innovation model in view of the various predictors expressed by the adjusted coefficient of determination for EUR

As presented in Figure 28, the bundle of factors that best predict innovation in EUR relates to the combination of HDI, BSS, and CS, with an adjusted R2 value of 0.8795. Note that in addition this combination of variables presents p-values less than 0.05 (see Appendix: Table 28) indicating that the observed results are statistically significant. The relevant equation of the model is expressed as follows:

$$GIS\ (EUR) = -47.60 + 73.70*HDI + 0.36*BSS + 0.24*CS \qquad (8)$$

As shown in equation (8), focusing on the most effective parameter, GIS will increase on average by 7.370 units for each 0.1 increase in HDI, net of the effects of changes due to BSS and CS. Evidently, the European union countries advance further innovation through knowledge intensive workers, strong connections of public with private sector as well as funding availability.

Comparing the regional data, it appears that although global innovation correlates well with social welfare, in case of developing regions such as CSA, the situation becomes vague. It is speculated that the deviation of CSA from the norm, comes from the heterogeneity that its relevant countries, namely India, Bangladesh, Iran, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan, Uzbekistan, present with each other in their societies, economies and functions.

The regional modeling of innovation highlights on the one hand the significant role of HDI in advancing innovation and on the other hand the customized effect of other parameters. Thus, current analysis identifies ways to bridge the technological global inequalities between countries, which could potentially prevent divergence in welfare (Hujo, 2026). For example, regions like LCN and CSA would benefit from the progress on their institutions and relevant policy stability. The institutional and regulatory environment is likely related to endogenous growth (Cvetanonić et al., 2019), which in turn may facilitate innovation. Moreover, regions such as SSA would boost their innovation score by improvements in infrastructure. Endogenous growth in underdeveloped regions is efficiently fueled by advancements in information and communication technologies. In that situation, human capital is augmented realizing significant productivity efficiency (Yuldoshboy et al., 2025). Besides, in rich countries business sophistication supports investments and contributes further to endogenous growth (Akkas and Altiparmak, 2023). Finally, it seems that almost in all regions credit supports innovation (Jeke et al. 2025).

In case of Greece, the country lies at the low level of the EUR region in terms of innovation score, however the country has well predicted GDP per capita in view of its innovative performance. Nevertheless, considering the level of human development one would expect a slightly higher level of innovation outcome. Interesting to note is the very low score on happiness and job satisfaction, which might relate with the moderate innovation performance that has been achieved.

Current analysis pinpointed countries with high GDP per capita, however without the corresponding innovative level, suggesting that innovation is a well-designed process and it has not emerged by luck (Haruyama, 2020). Governmental policies should enhance the capabilities of its citizens to succeed in absorbing the technological spillover and create new knowledge. Efficient national innovation systems can transform the least developed countries from imitators to innovators and increase the functionalities of the society advancing in parallel welfare. By this way the "growth paradox" wherein technology shifts wealth from labor to capital, and aggregate productivity increases but vulnerable worker segments experience absolute welfare losses, could be likely evaded (Li, 2026). Besides, job satisfaction along with social life influences happiness (Cuesta-Valiño, 2024). Innovation is positively associated with the very satisfied employees who drive growth and in turn, may further fuel economic progress and social welfare.

6. Conclusions

6.1 Concluding remarks

Current analysis underlines that the innovative potential of a country correlates fairly with its social welfare. Welfare and innovation metrics from 131 countries around the globe have been analyzed. It has been found that innovation score and the number of PCT patent applications per capita are positively associated with the progress of welfare for a country as this is expressed through its GDP per capita, human development index, happiness report and job satisfaction. However, the best fit appears for human development index, which compiles national data on life expectancy at birth, expected years of schooling, mean years of schooling and gross national income per capita. Outliers of the correlations appear to be countries which either exploit natural resources and operate services far beyond the functionalities of its citizens or experience societal inequalities.

A multiple regression analysis has been performed in the regions around the world to identify the parameters which affect innovation. In the developed countries efficient technical change is assisted by capital investment, market and business sophistication, while in the least developed regions the innovation advancement is supported by regulatory quality and general infrastructure. Nevertheless, in all cases human development and available credit are basic ingredients of technological advancement.

Regarding Greece, the low innovative score explains sufficiently the measured welfare of the society, however it shows also the way to advance. Its economic growth can be expanded following the endogenous growth principles. The applied national innovation system should advance further innovation through competent technology transfer, development of knowledge intensive workers, creation of strong connections of the public with the private sector as well as establishing funding readiness.

6.2 Limitations and future research directions

Correlations of present study have been directed to variables, which reveal rather meaningful relationships with each other, such as innovation with HCRS or BSS. In that case correlation indices can be fictitiously inflated, which may limit the impact of the findings. The exploited indicators are produced by different organizations with different methodologies and weightings. This fact may affect comparability and should be taken into consideration in the interpretations of the results.

Furthermore, the correlations and regressions of current work are performed with cross-sectional data, so causal relationships are not documented. The relationships may be bidirectional and are certainly influenced by third variables. Besides, existence of regions with narrow number of countries such as the CSA, which in addition contain substantial outliers could potentially affect the correlation analysis and outcome generation.

Future research could be directed to more extended composite metrics to correlate with innovation and welfare, which could potentially investigate the existence of confounding variables. Furthermore, analyzing the outliers in the various regions around the world and performing comparative case studies might unveil interesting findings for welfare and innovation indices for societies with different backgrounds. Finally, conducting longitudinal studies on an extended period for the various regions around the globe could amend disputable outcomes, and give insights into long term trends and pivotal shifts.

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Appendix A: "Figures"

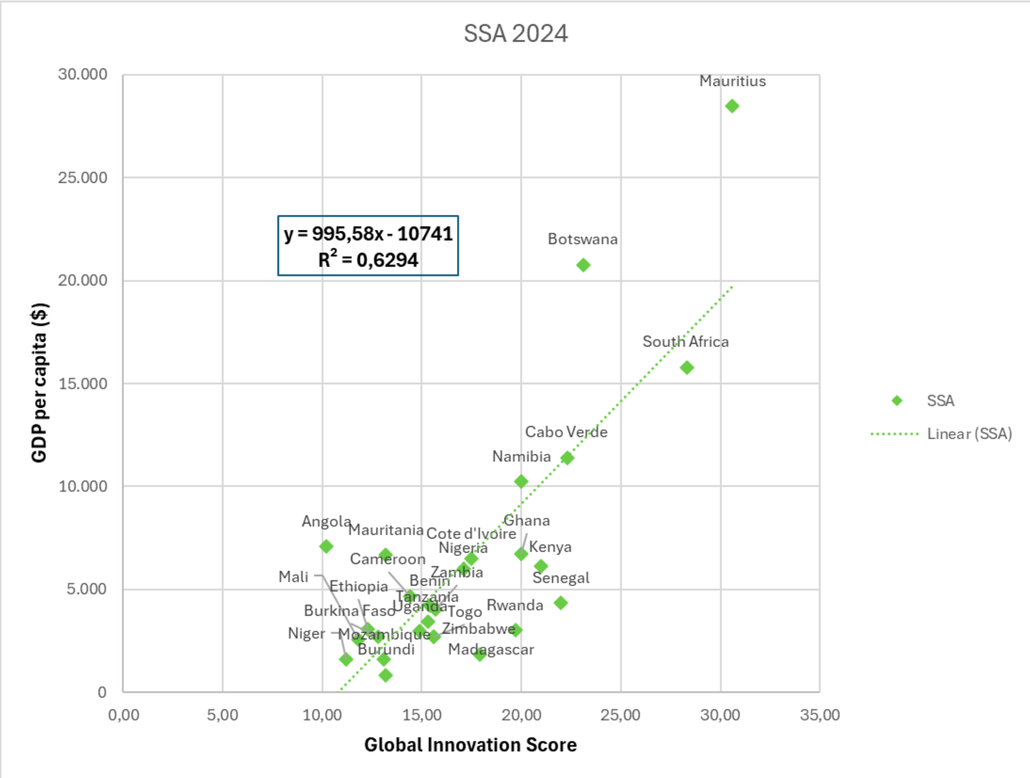


Figure 1. The GDP per capita versus the Global Innovation Score of SSA region

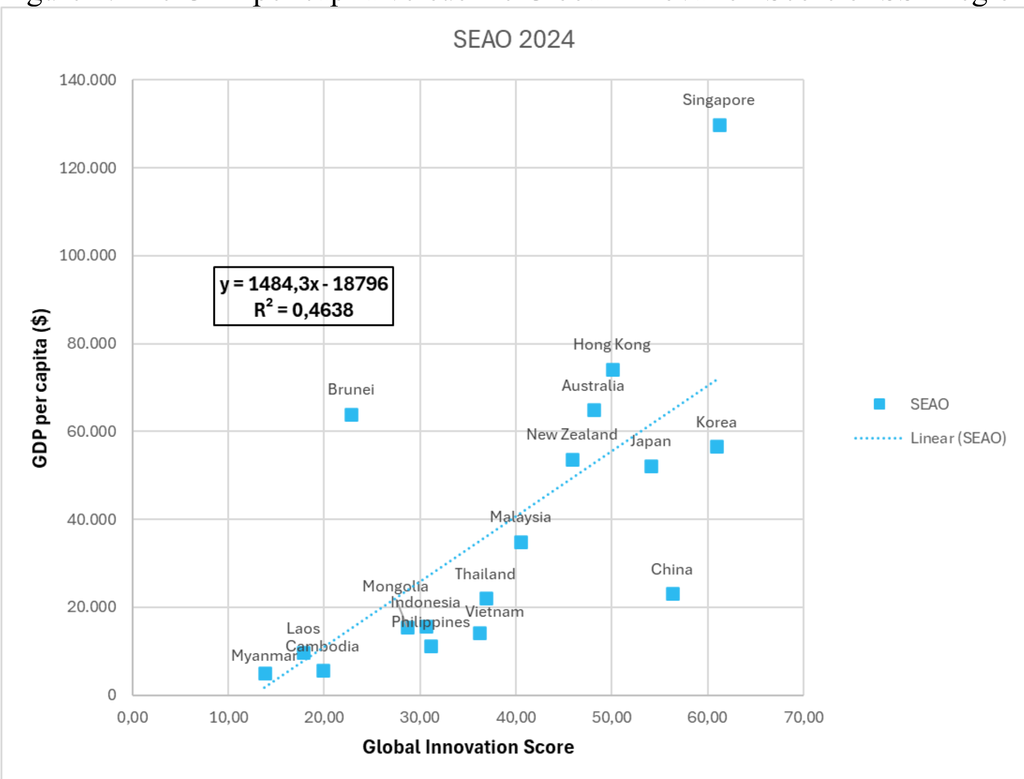


Figure 2. The GDP per capita versus the Global Innovation Score of SEAO region

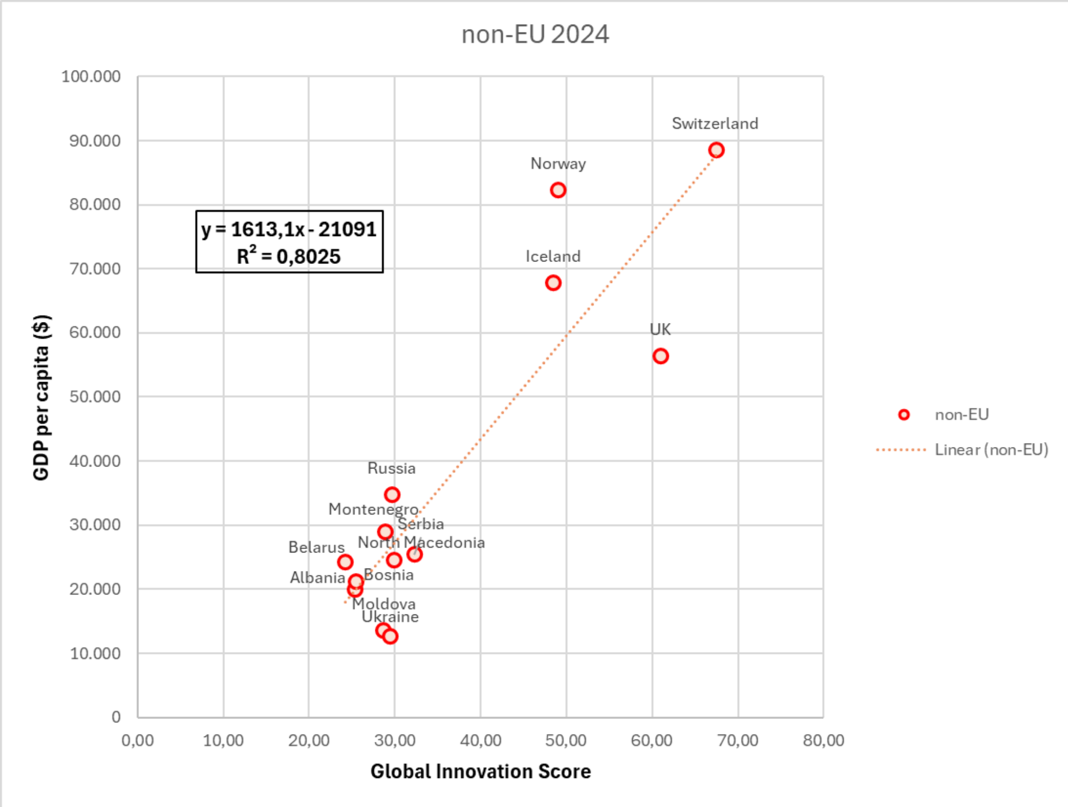


Figure 3. The GDP per capita versus the Global Innovation Score of non-EU

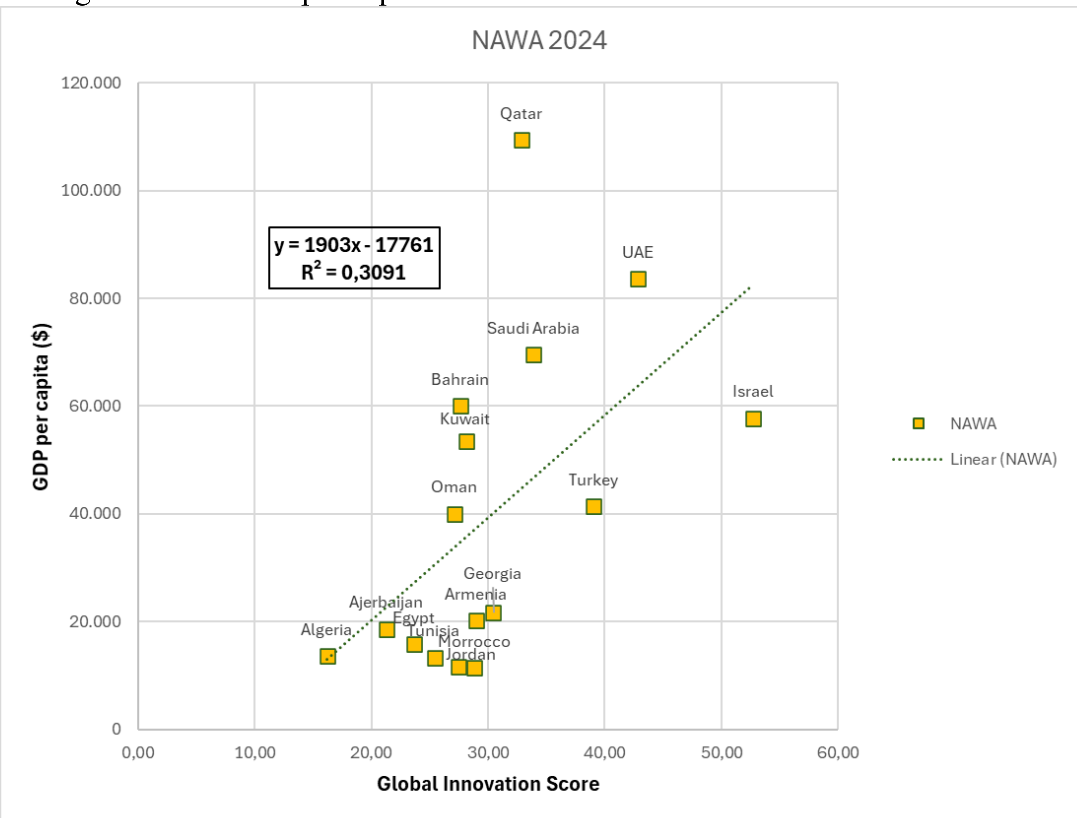


Figure 4. The GDP per capita versus the Global Innovation Score of NAWA region

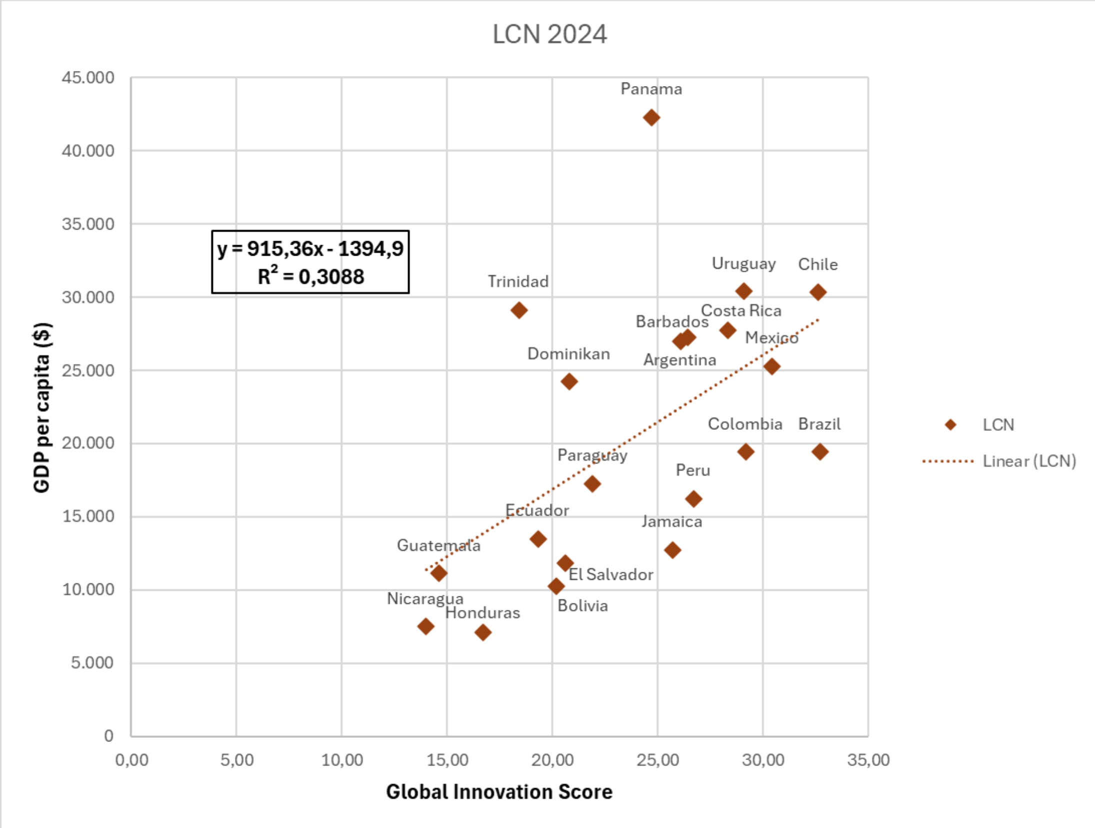


Figure 5. The GDP per capita versus the Global Innovation Score of LCN region

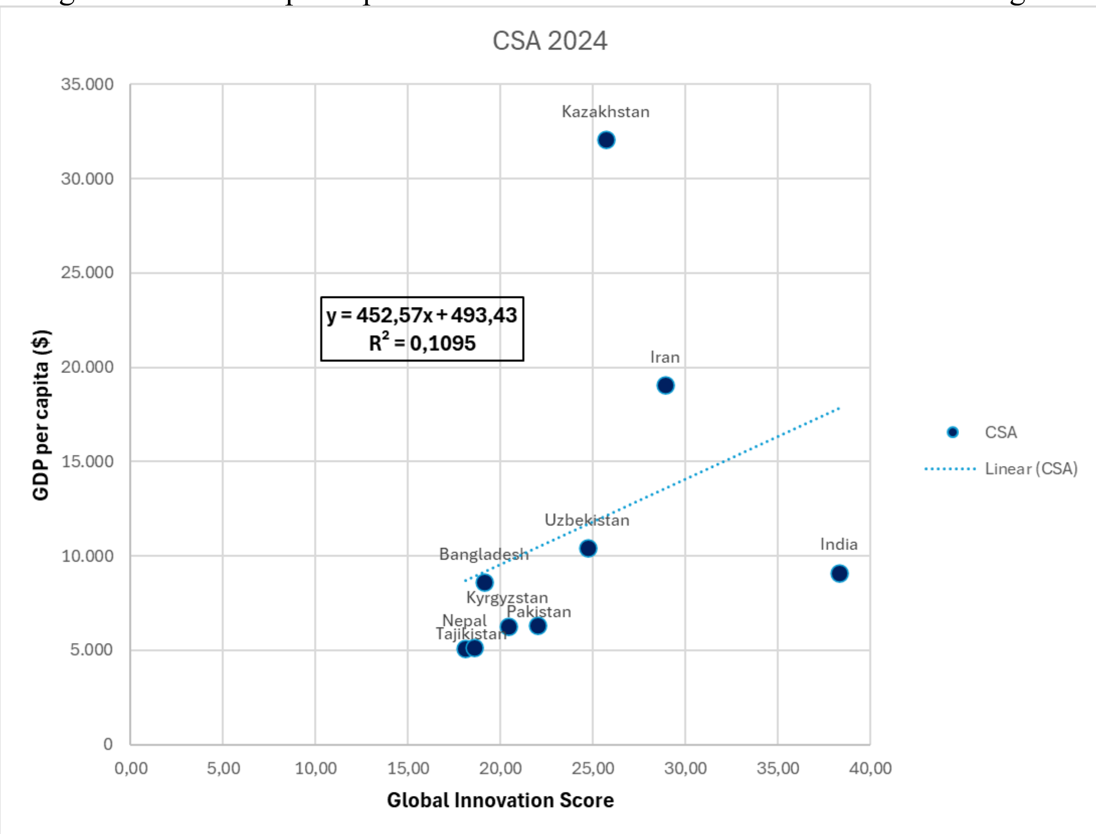


Figure 6. The GDP per capita versus the Global Innovation Score of CSA region

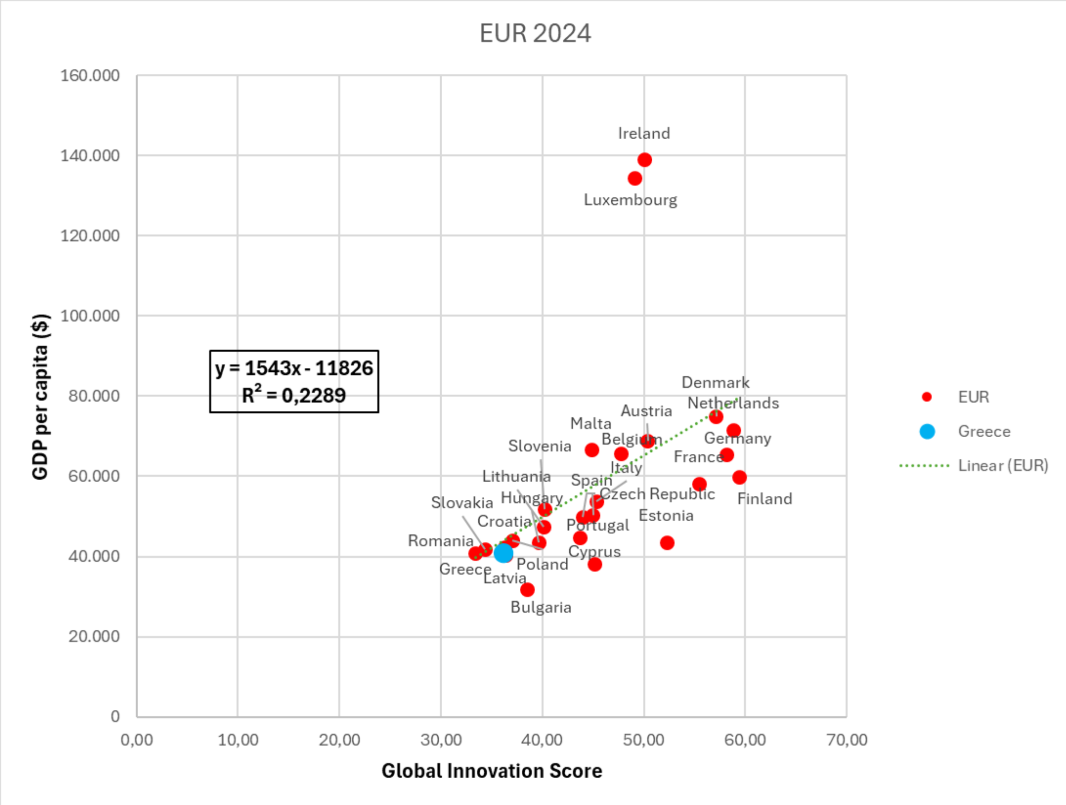


Figure 7. The GDP per capita versus the Global Innovation Score of EUR

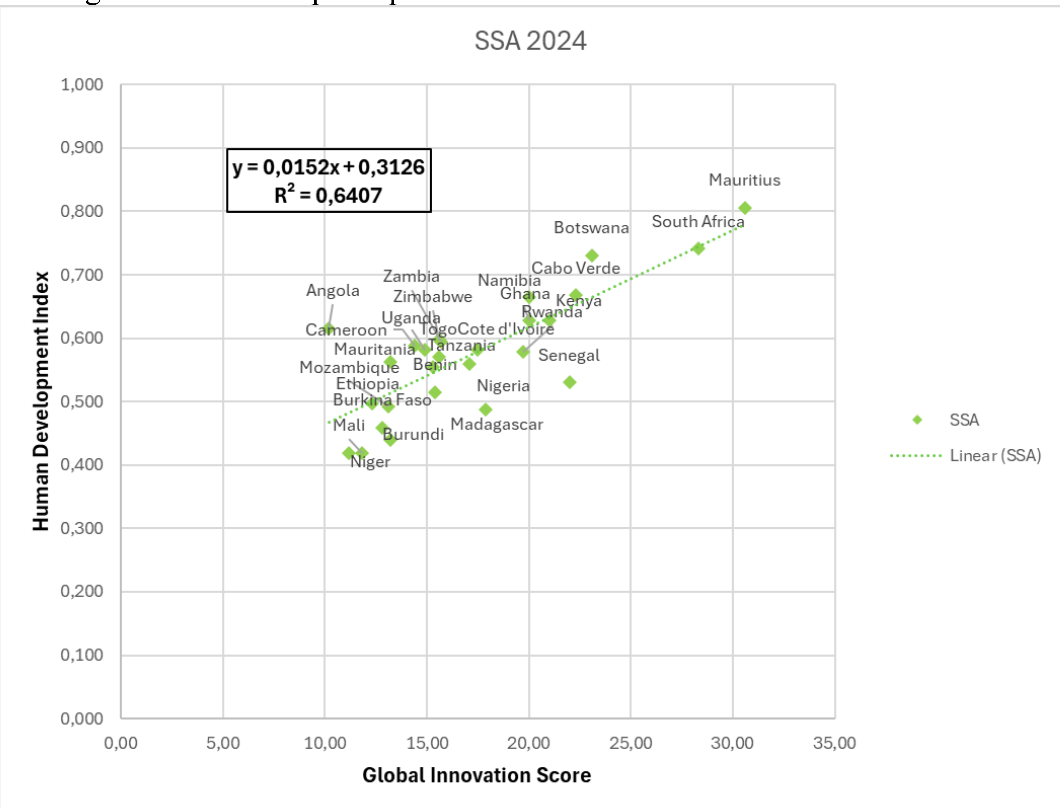


Figure 8. The HDI versus the Global Innovation Score of SSA region

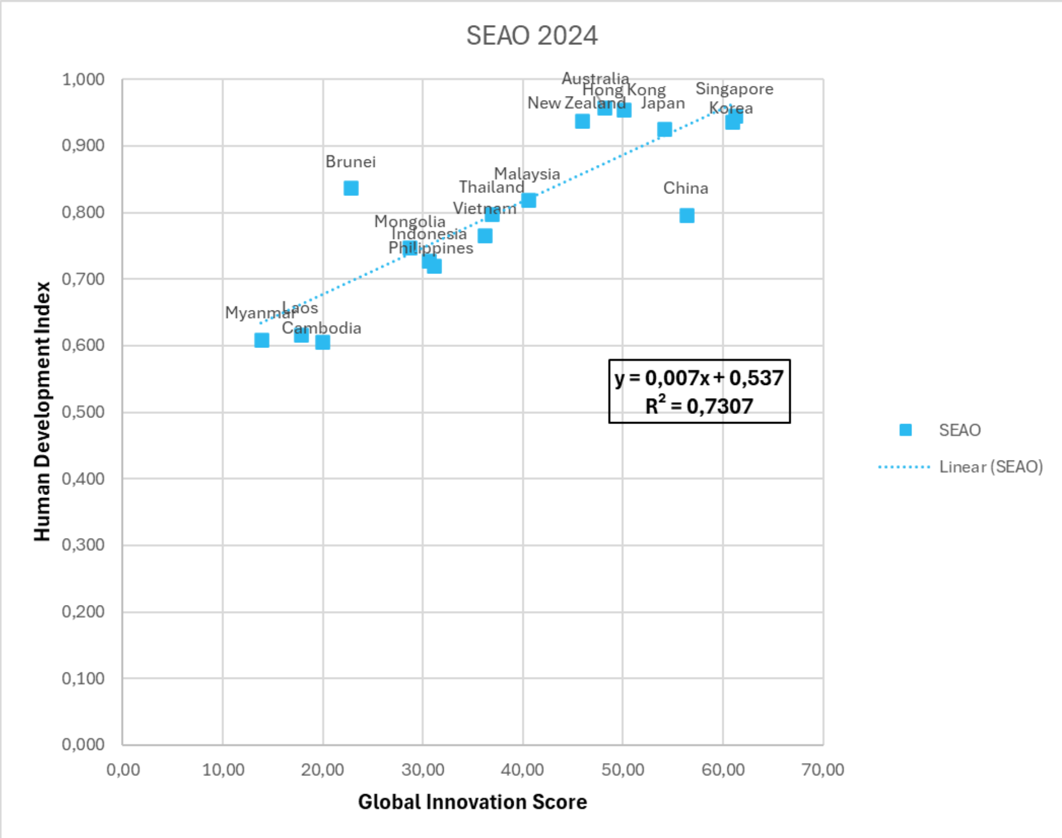


Figure 9. The HDI versus the Global Innovation Score of SEAO region

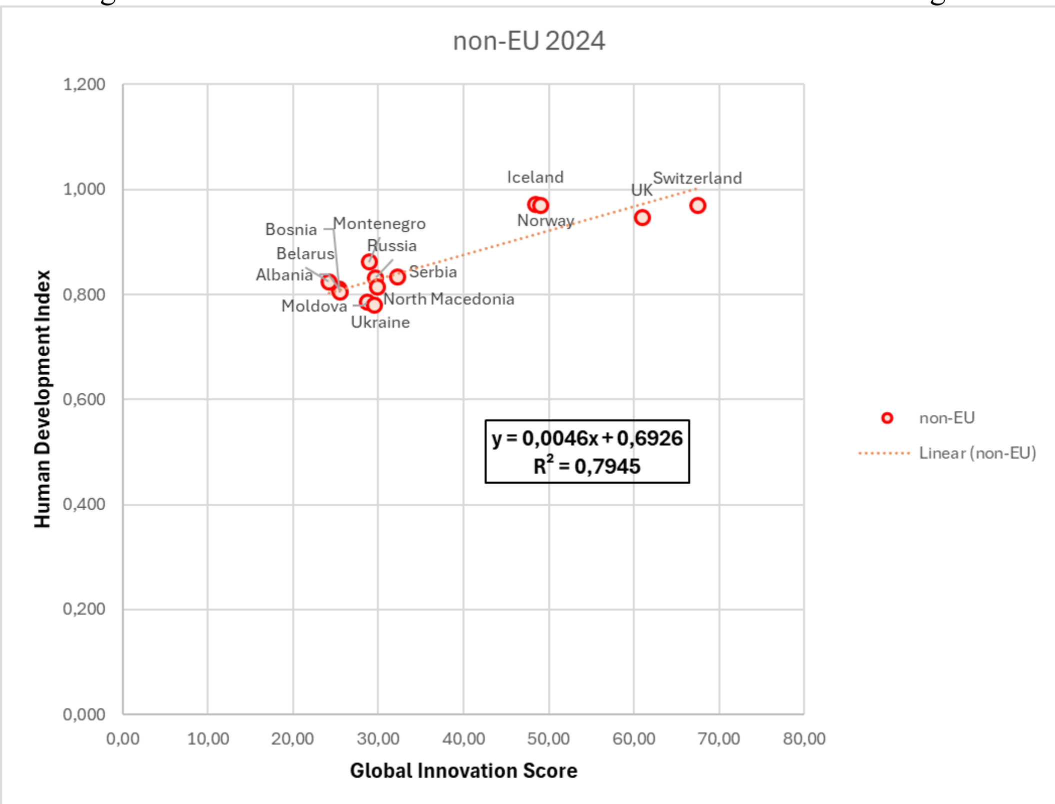


Figure 10. The HDI versus the Global Innovation Score of non-EU

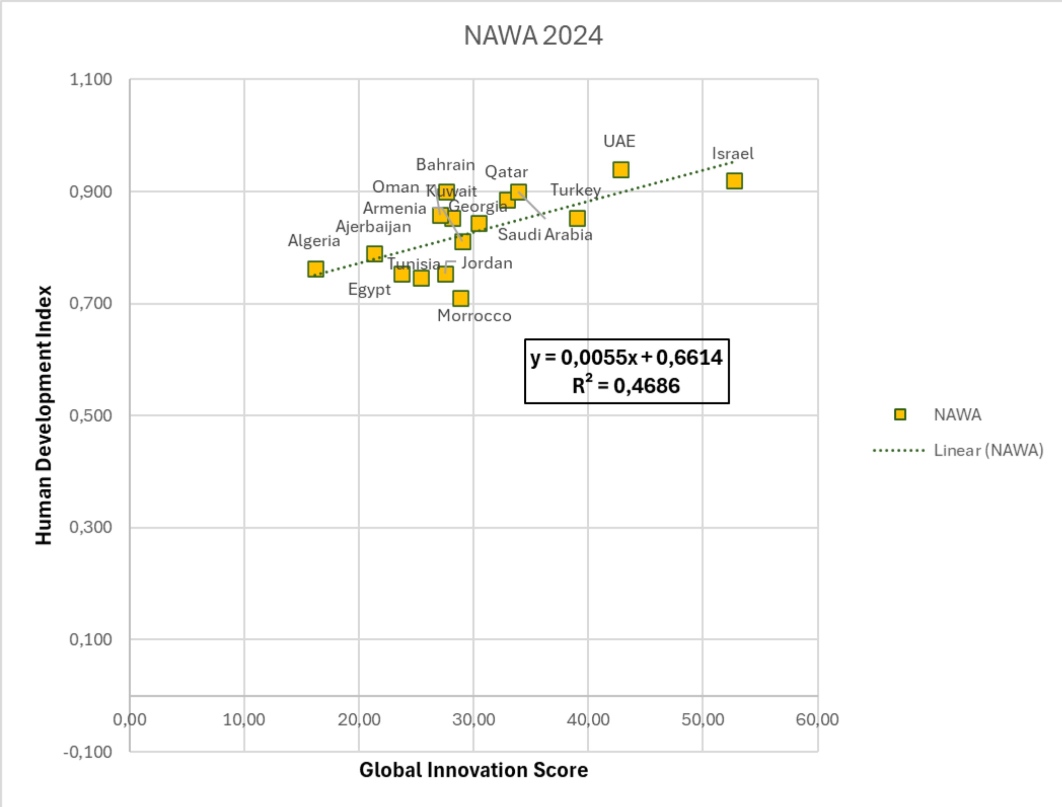
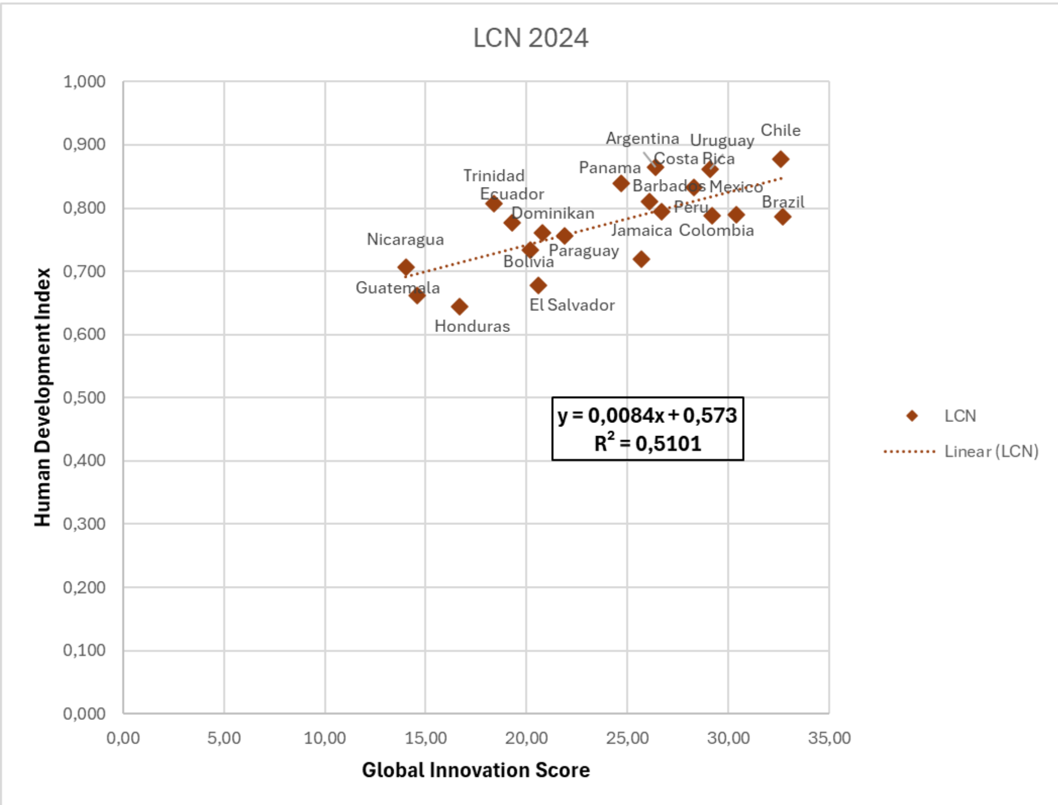


Figure 11. The HDI versus the Global Innovation Score of NAWA region



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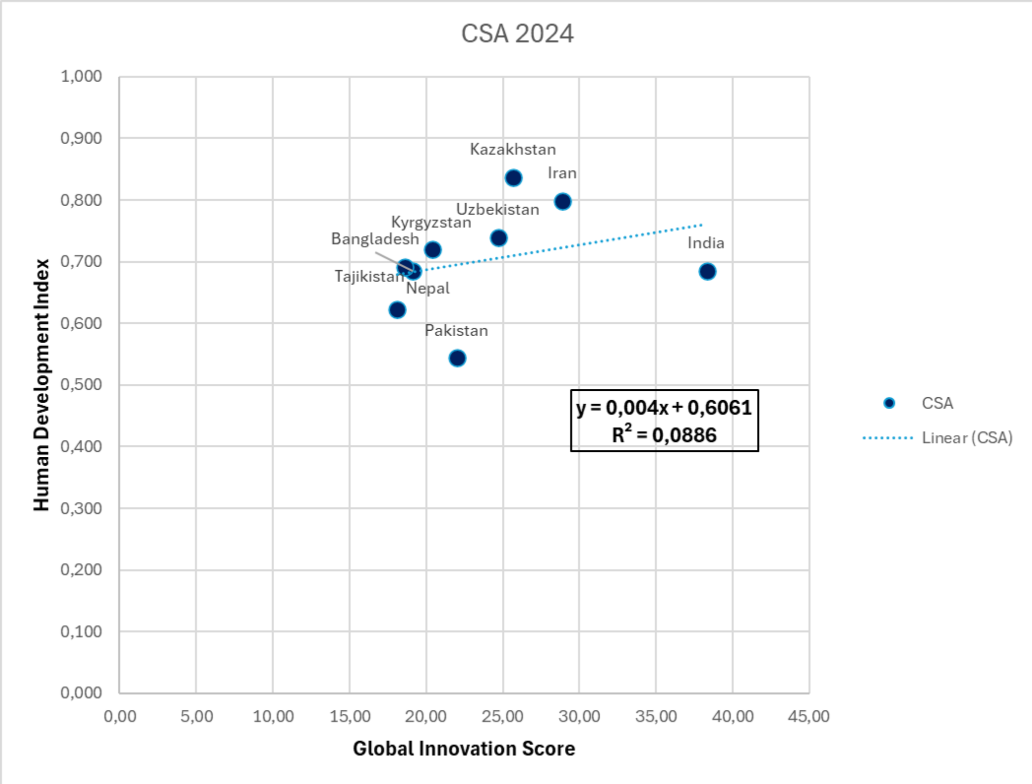


Figure 13. The HDI versus the Global Innovation Score of CSA region

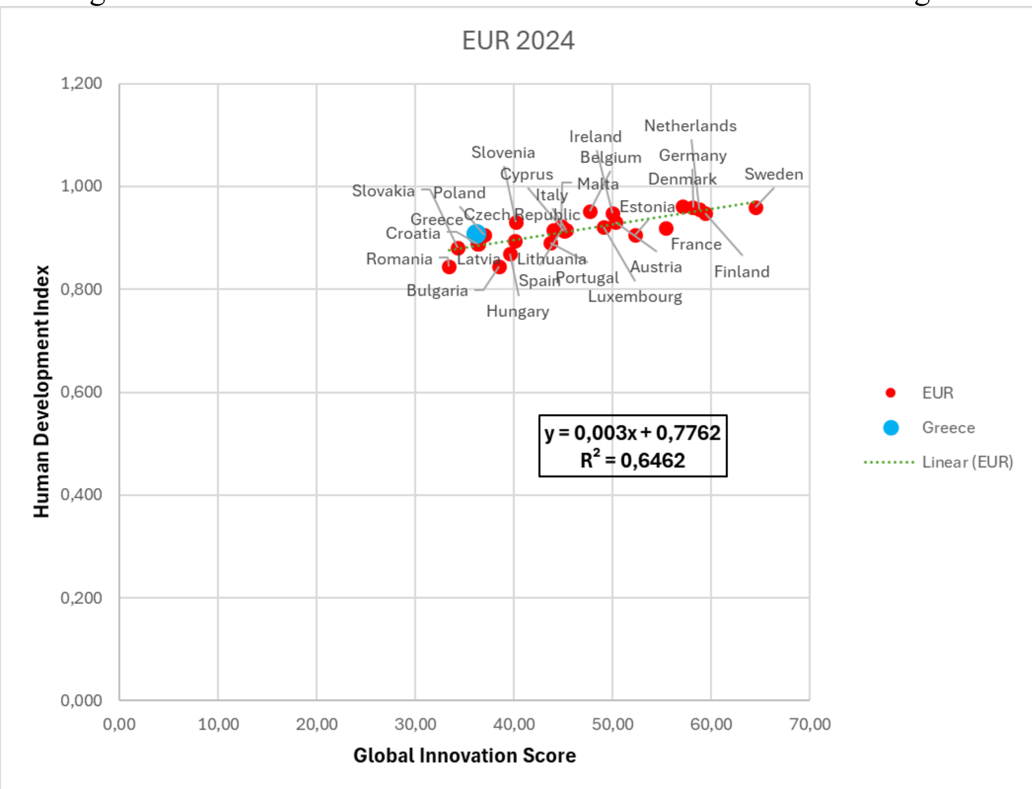


Figure 14. The HDI versus the Global Innovation Score of EUR

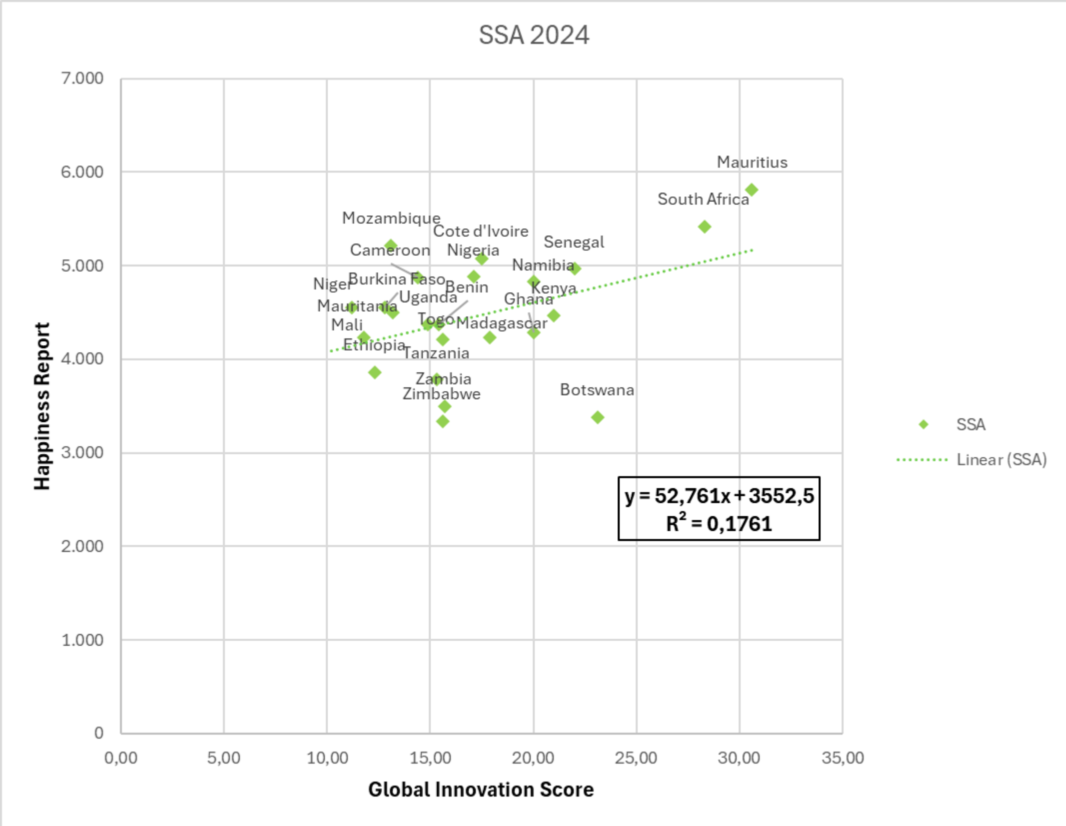


Figure 15. The Happiness Report versus the Global Innovation Score of SSA

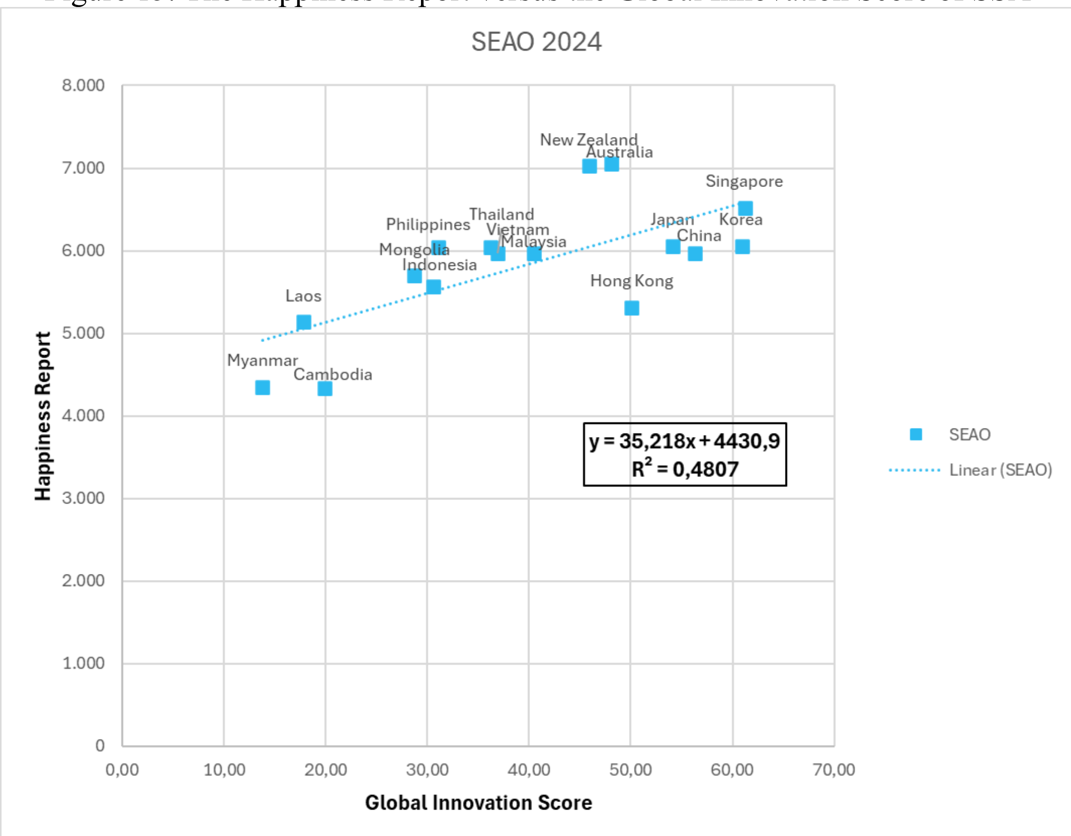


Figure 16. The Happiness Report versus the Global Innovation Score of SEAO

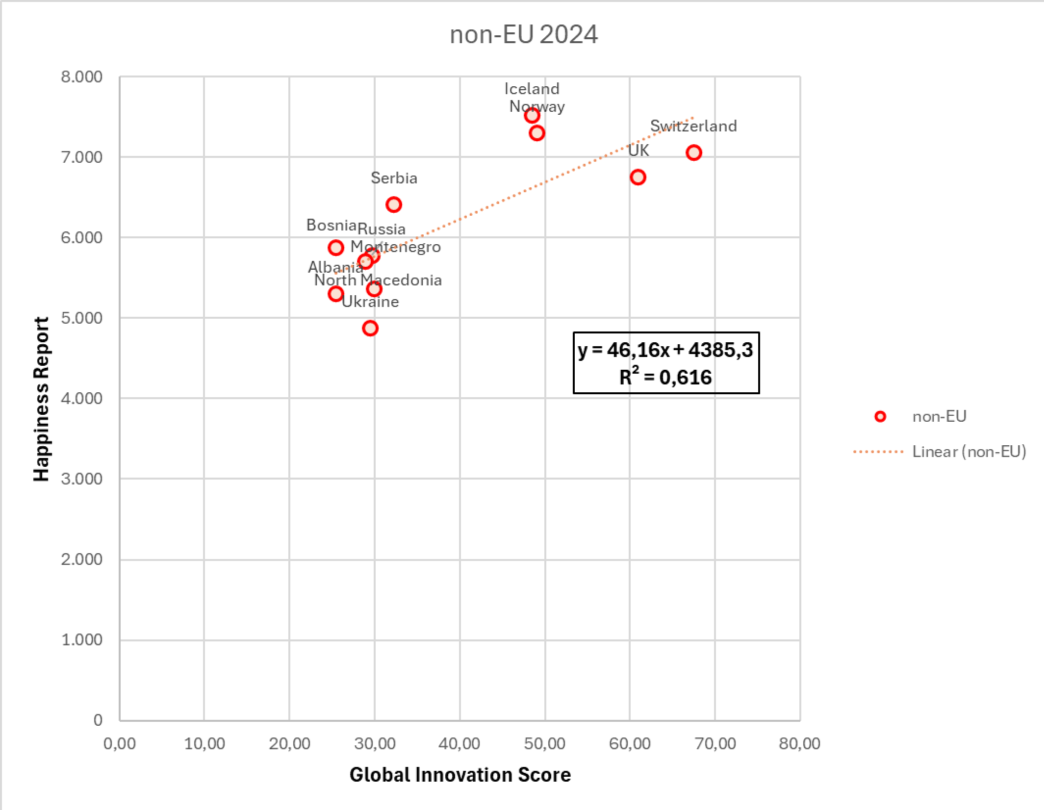
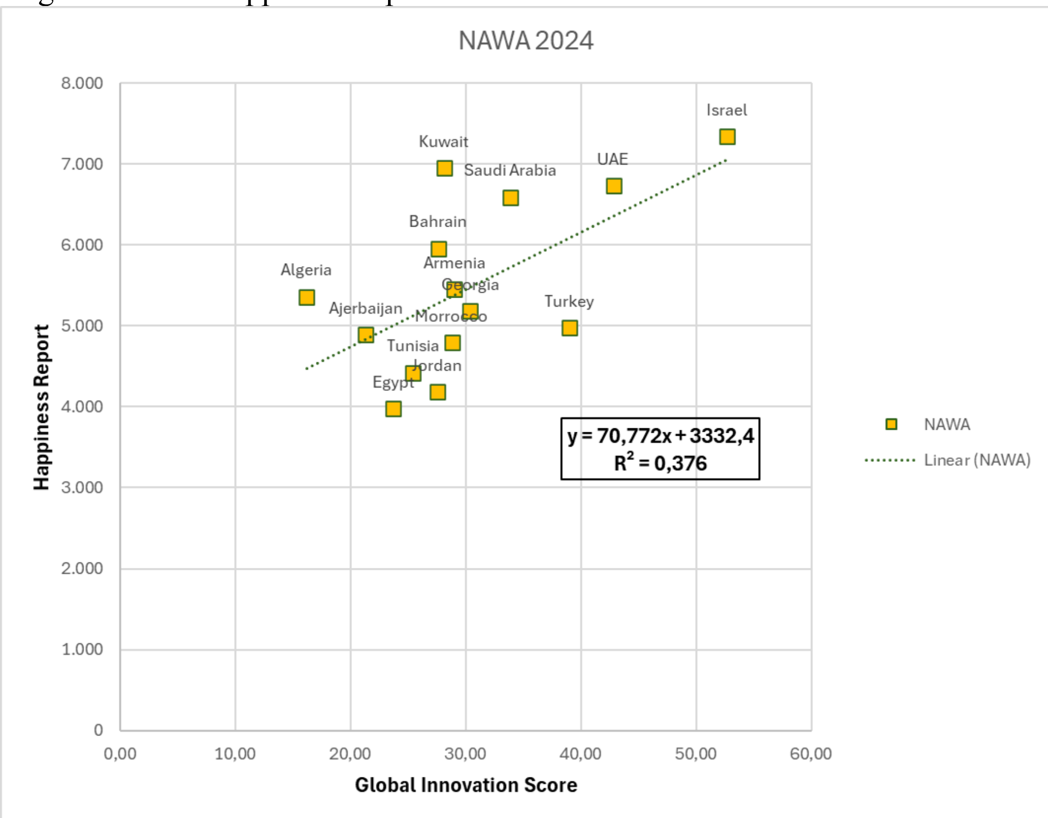


Figure 17. The Happiness Report versus the Global Innovation Score of non-EU



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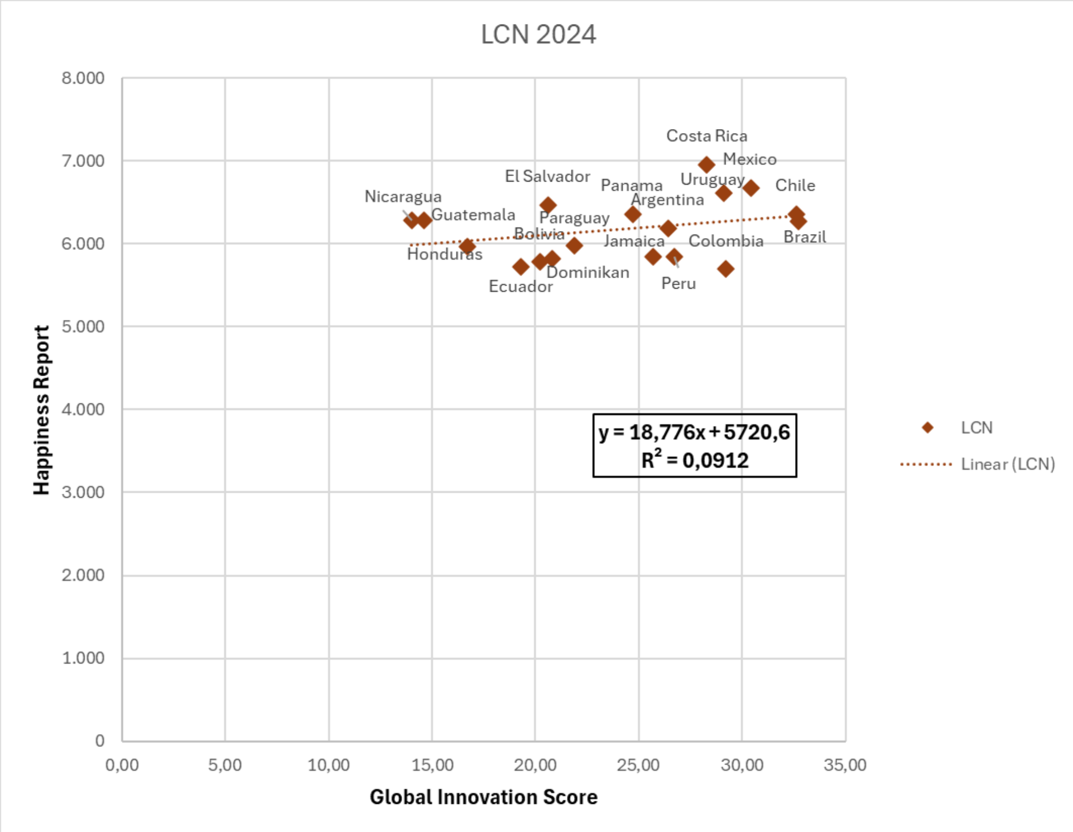


Figure 19. The Happiness Report versus the Global Innovation Score of LCN

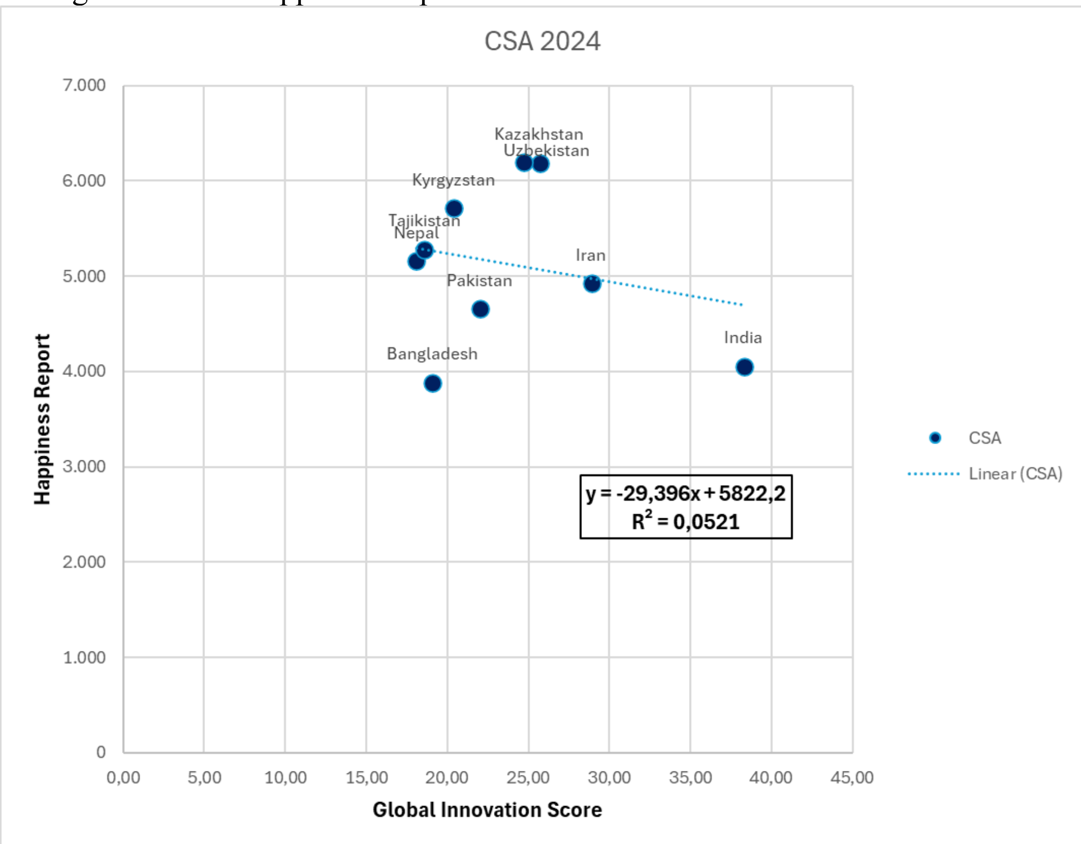


Figure 20. The Happiness Report versus the Global Innovation Score of CSA

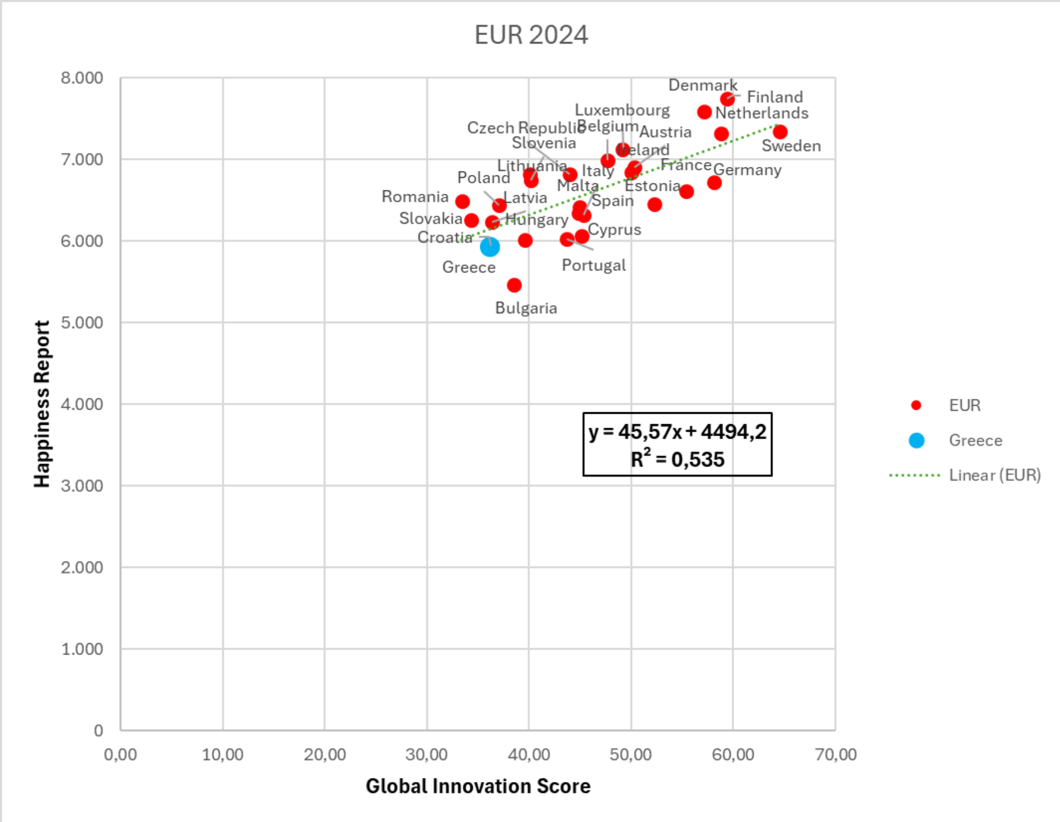


Figure 21. The Happiness Report versus the Global Innovation Score of EUR

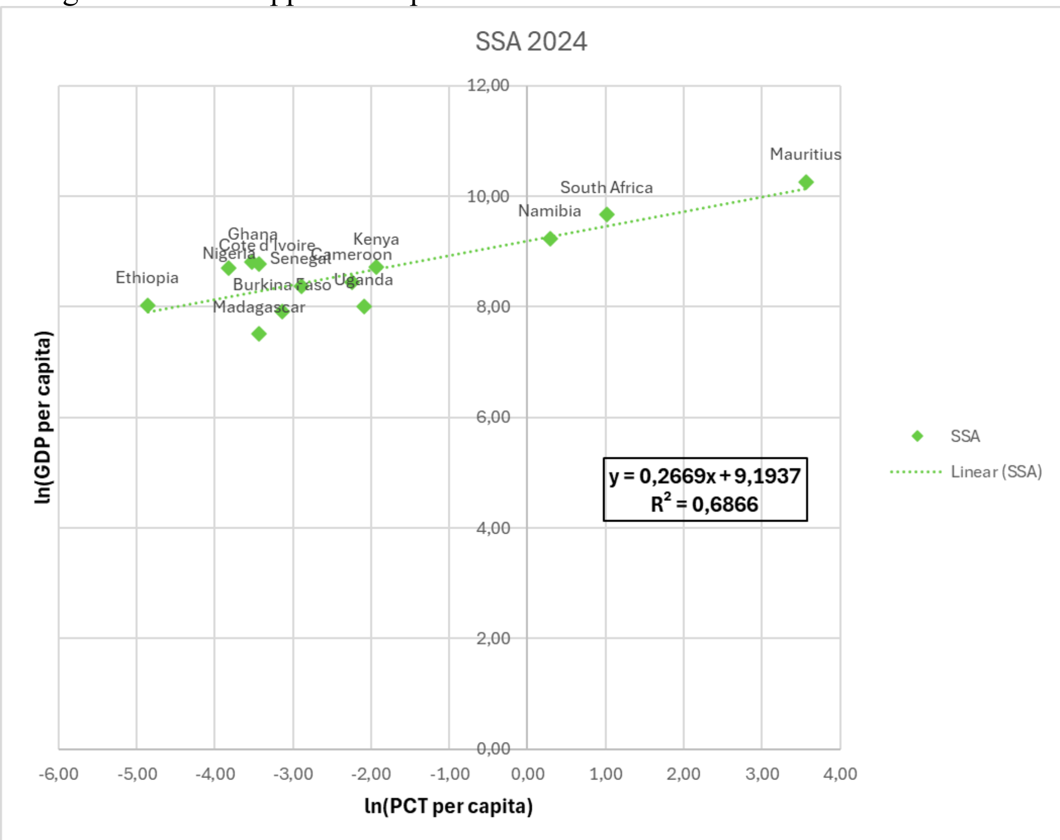


Figure 22. The log-log plot of the GDP per capita versus the PCT per capita of SSA

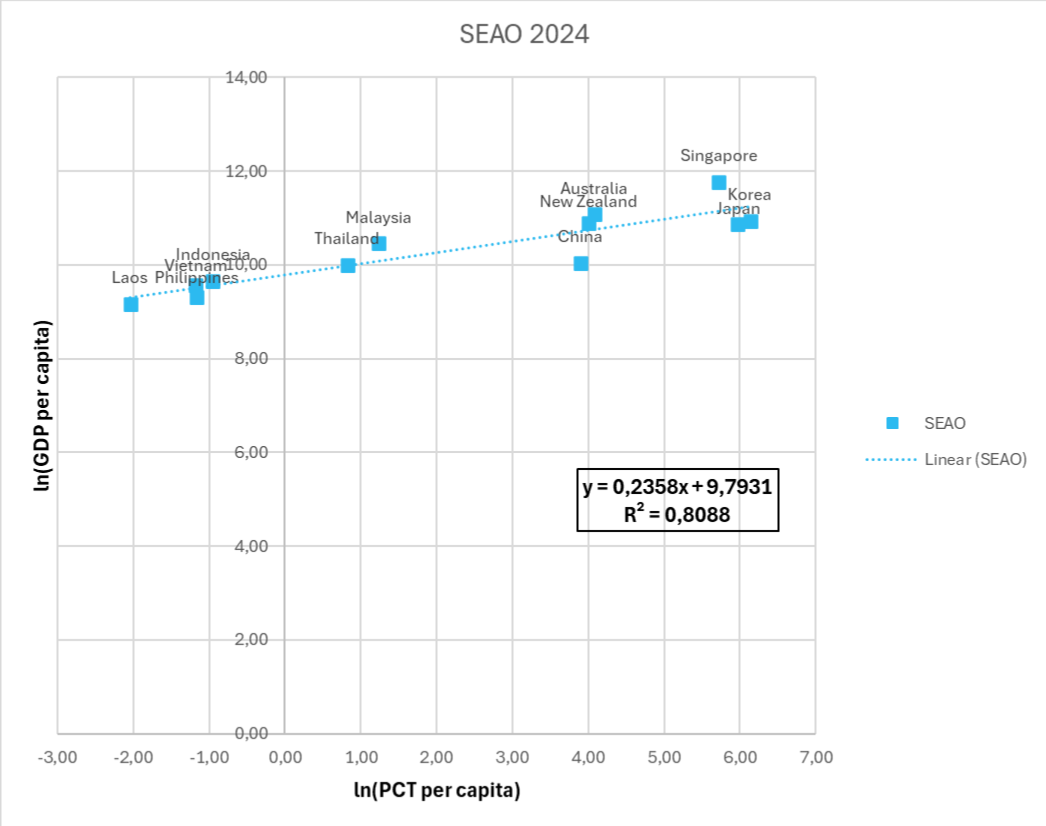


Figure 23. The log-log plot of GDP per capita versus the PCT per capita of SEAO

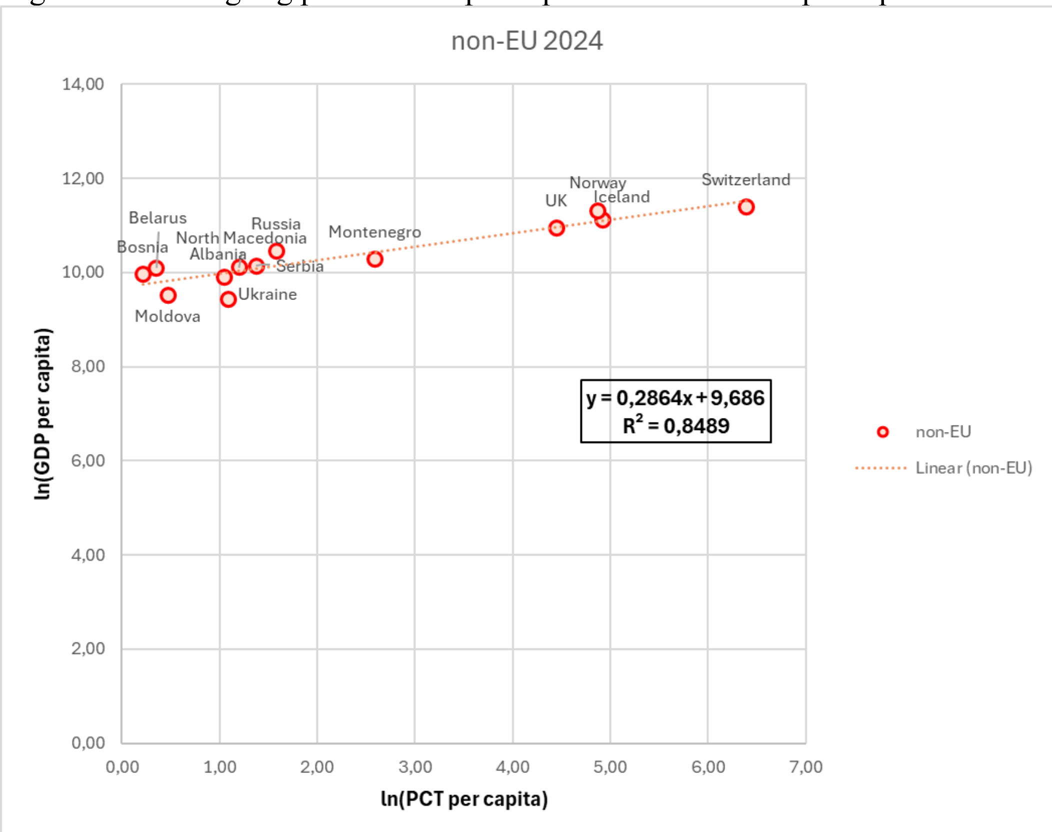


Figure 24. The log-log plot of GDP per capita versus the PCT per capita of non-EU

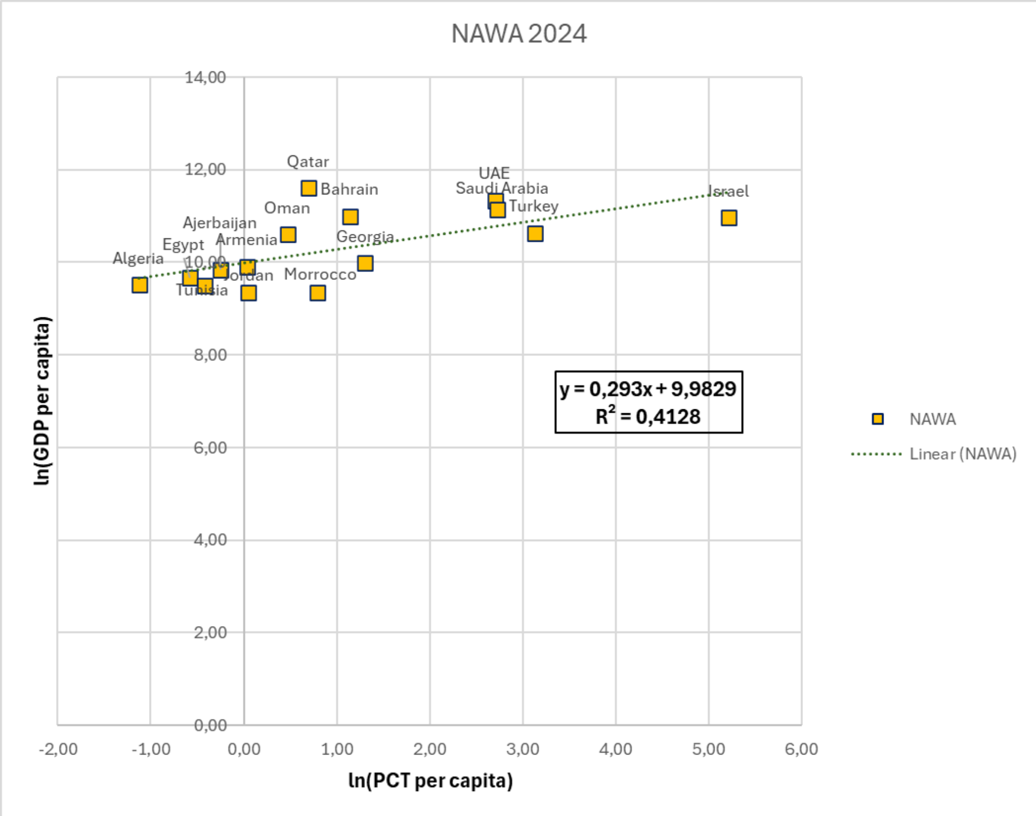


Figure 25. The log-log plot of GDP per capita versus the PCT per capita of NAWA

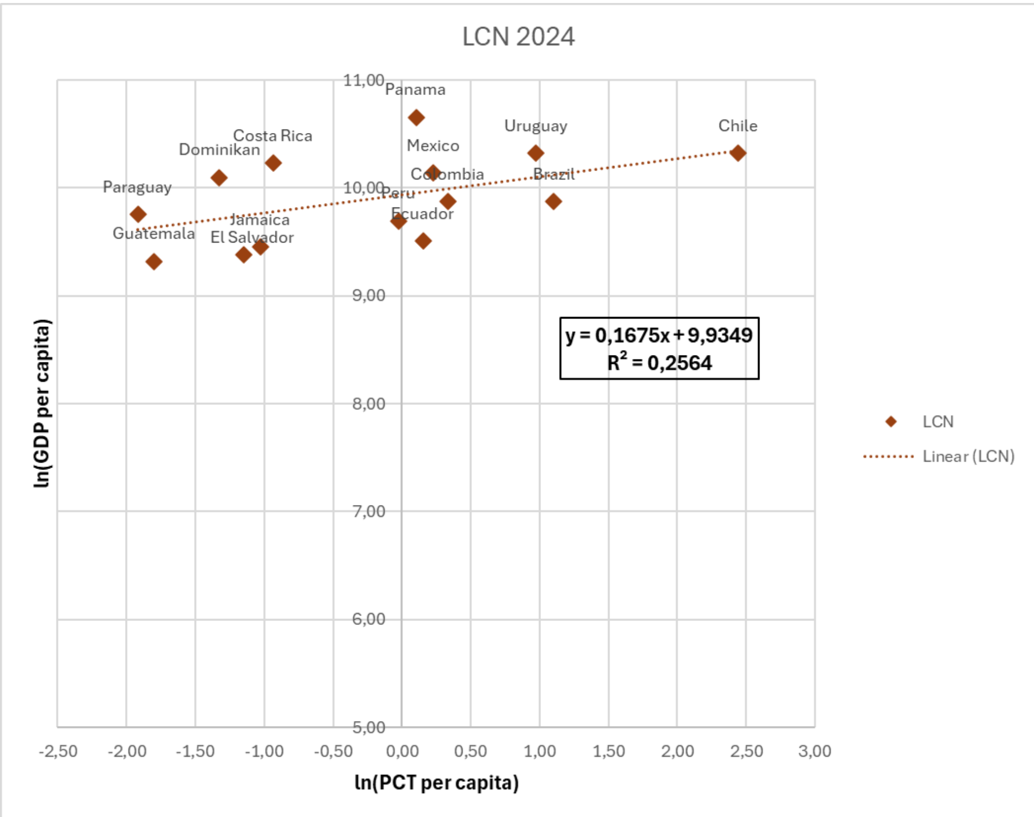


Figure 26. The log-log plot of GDP per capita versus the PCT per capita of LCN

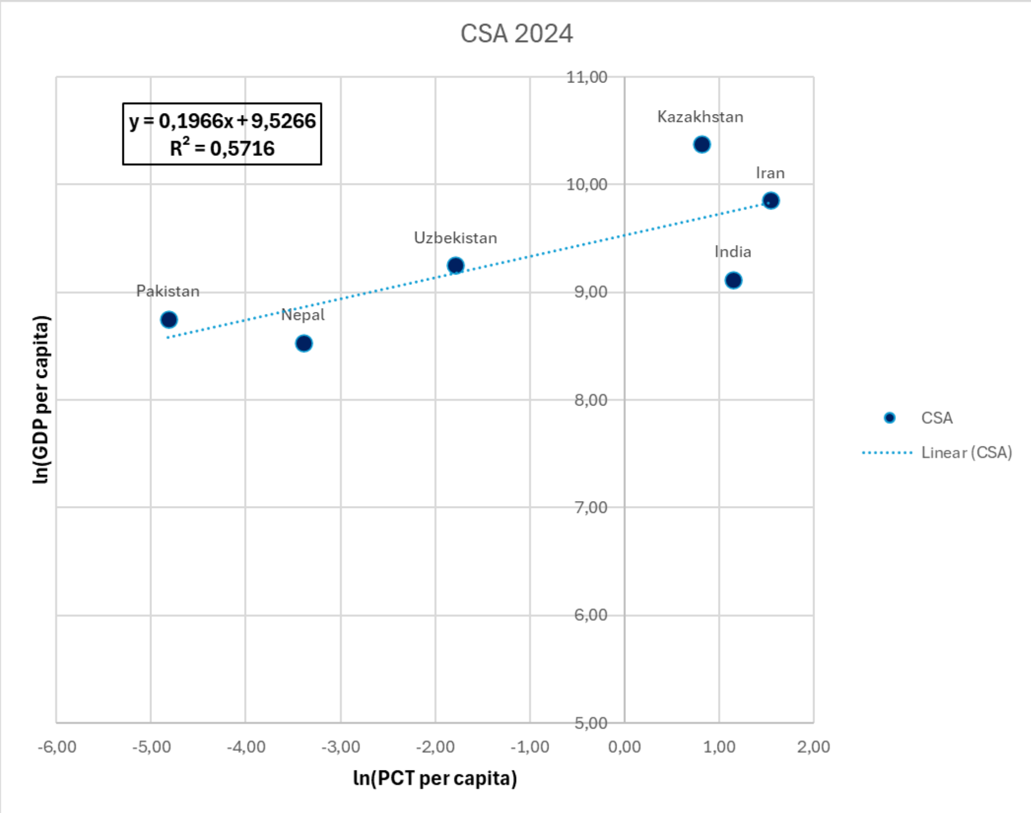


Figure 27. The log-log plot of GDP per capita versus the PCT per capita of CSA

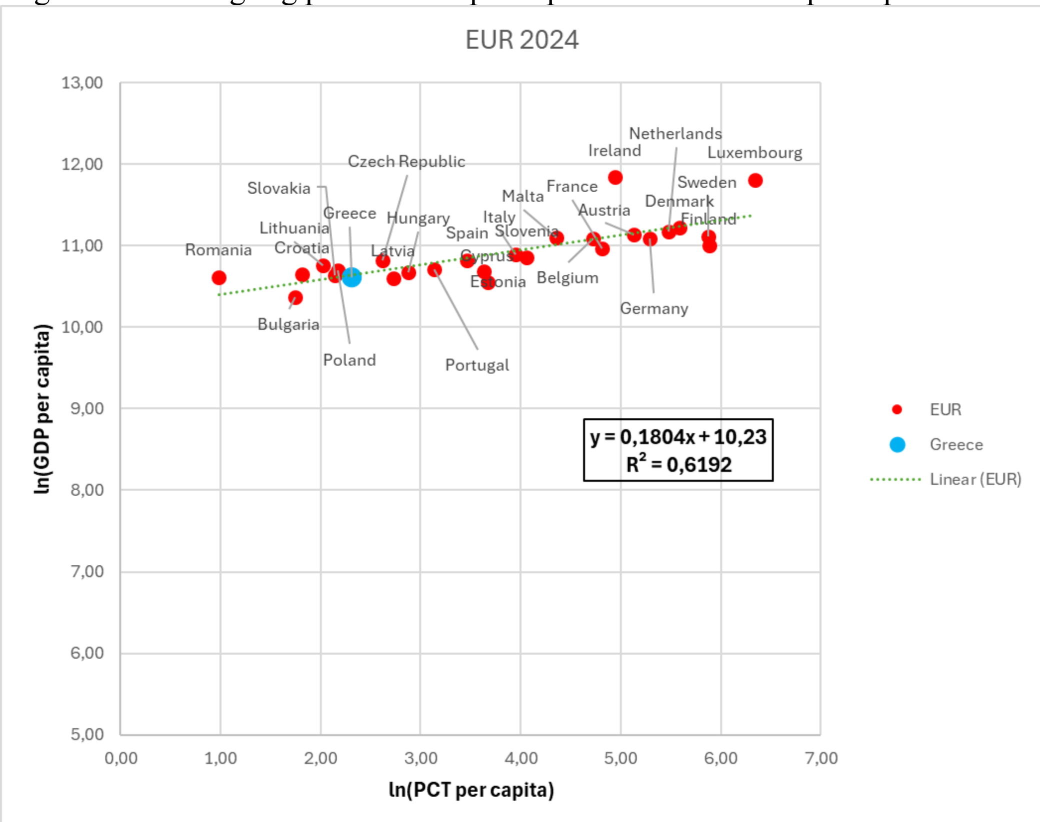


Figure 28. The log-log plot of GDP per capita versus the PCT per capita of EUR

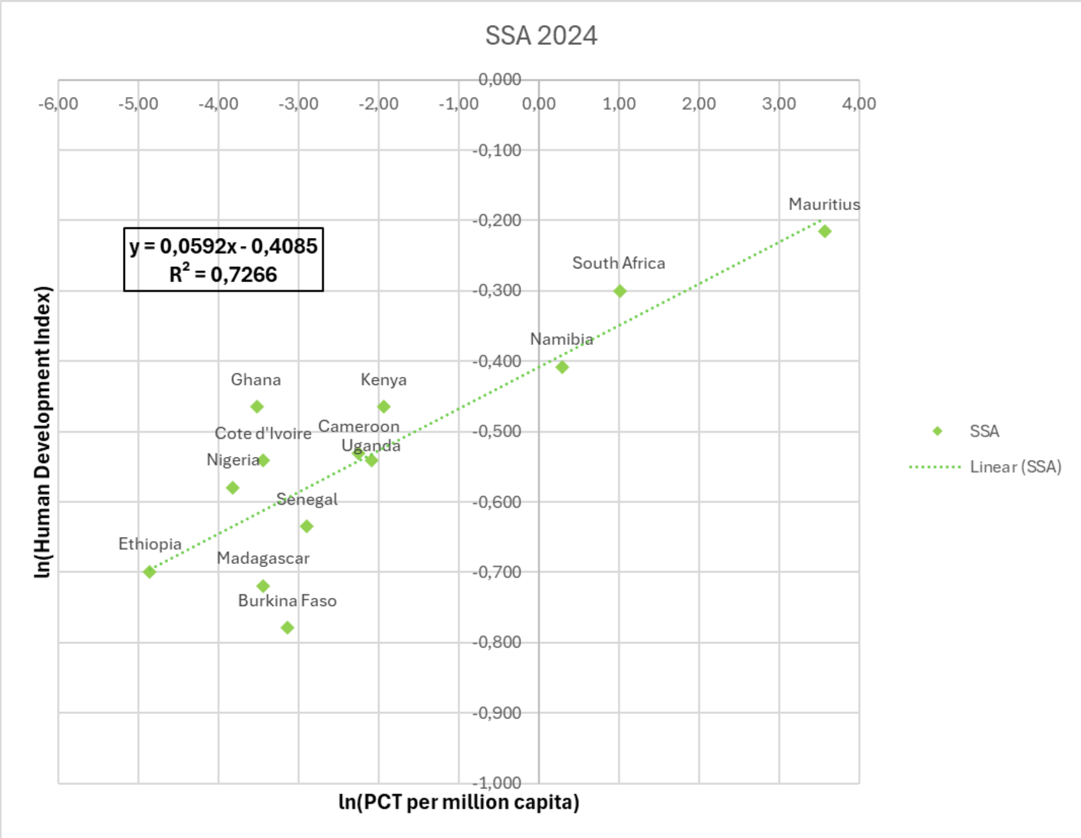
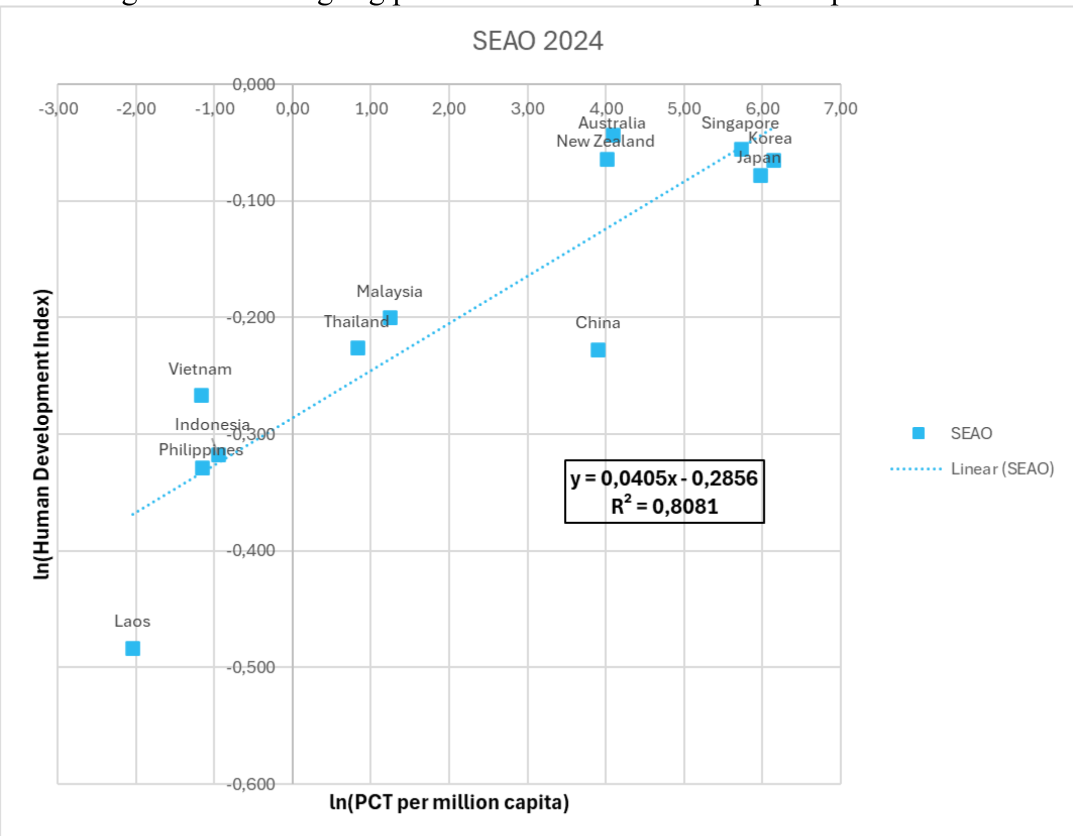


Figure 29. The log-log plot of HDI versus the PCT per capita of SSA



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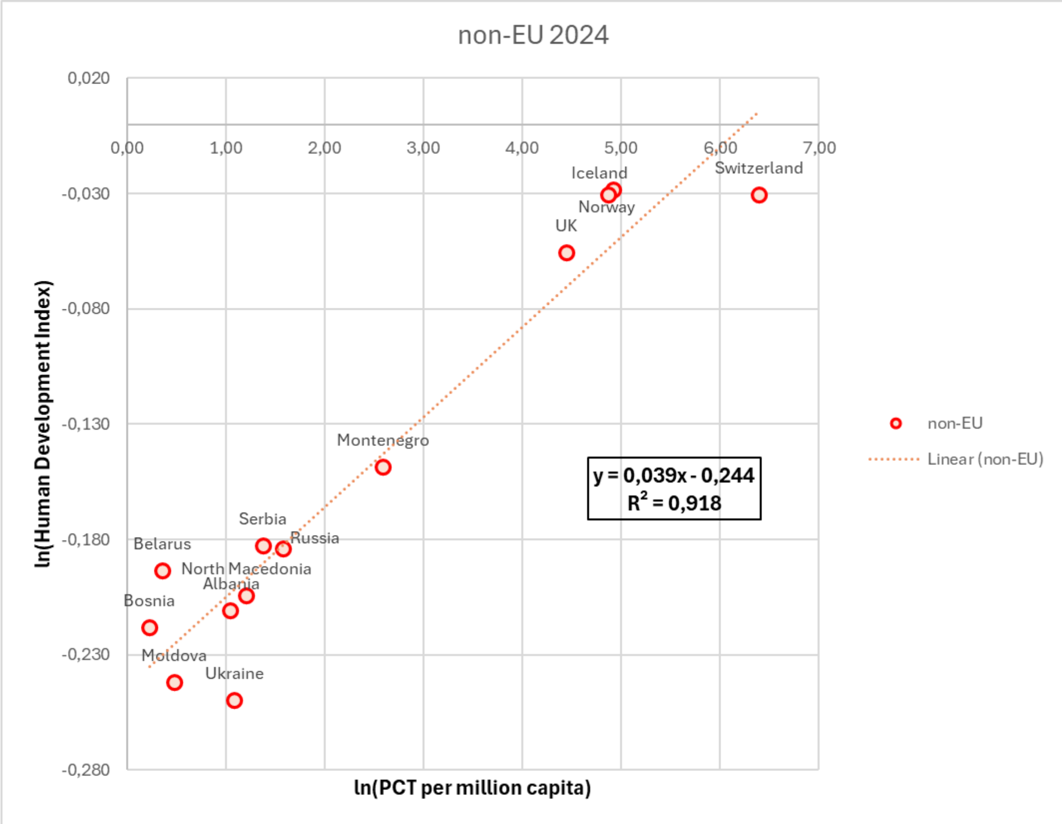

Figure 31. The log-log plot of HDI versus the PCT per capita of non-EU

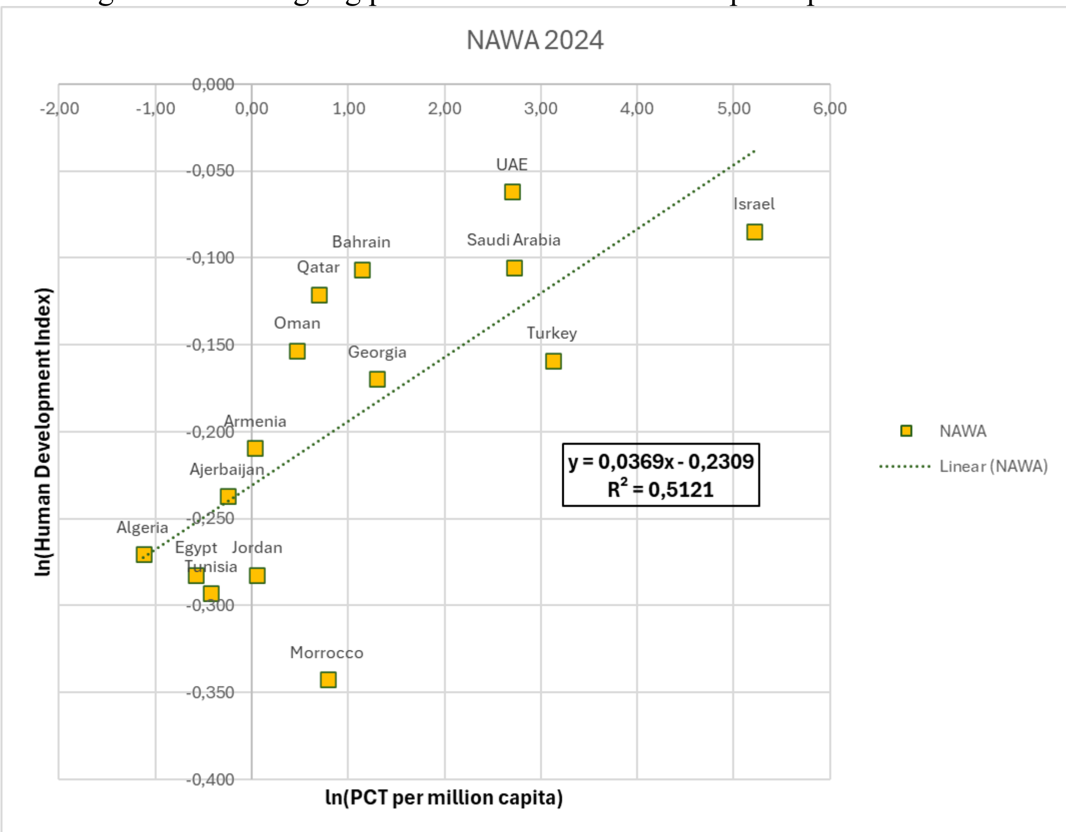

Figure 32. The log-log plot of HDI versus the PCT per capita of NAWA

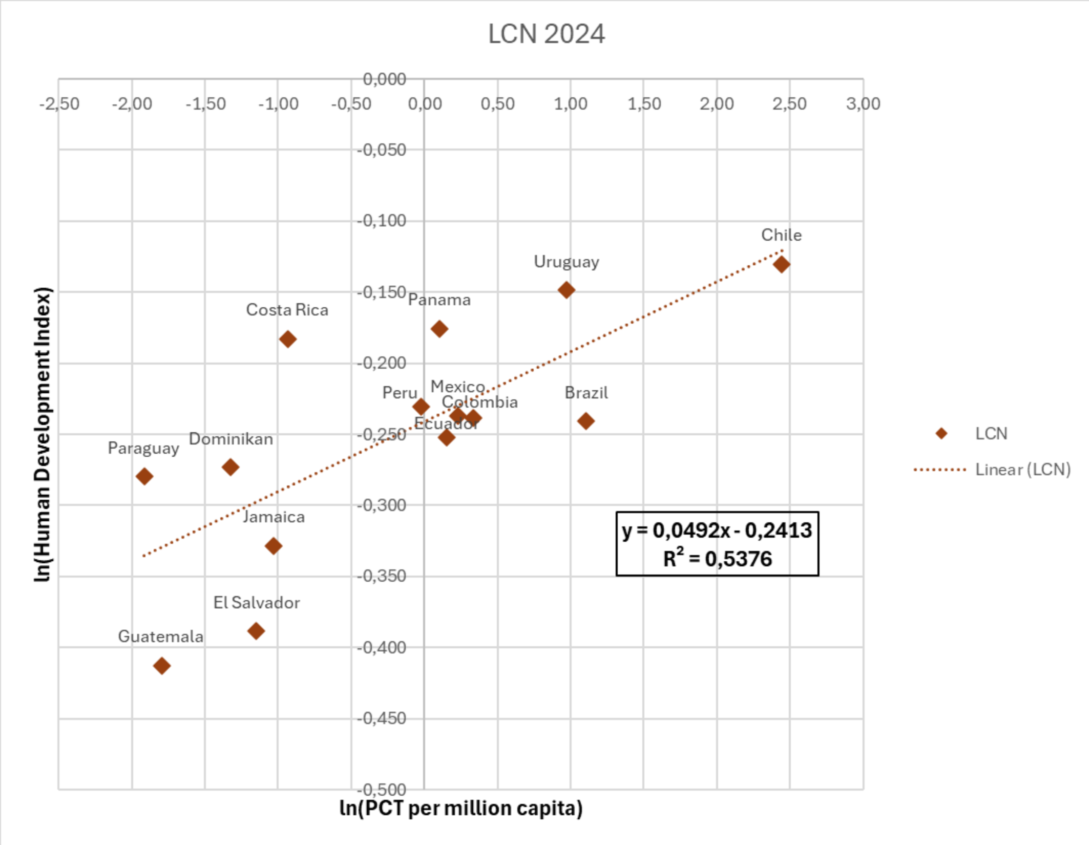

Figure 33. The log-log plot of HDI versus the PCT per capita of LCN

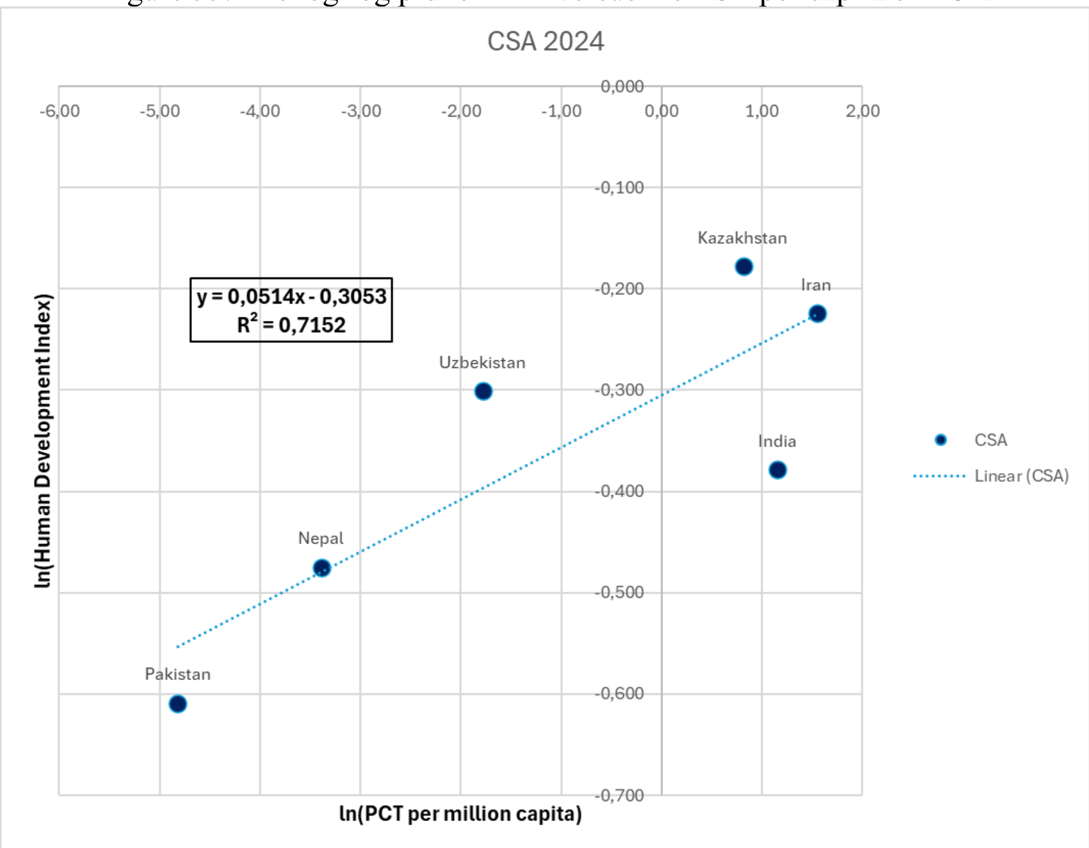

Figure 34. The log-log plot of HDI versus the PCT per capita of CSA

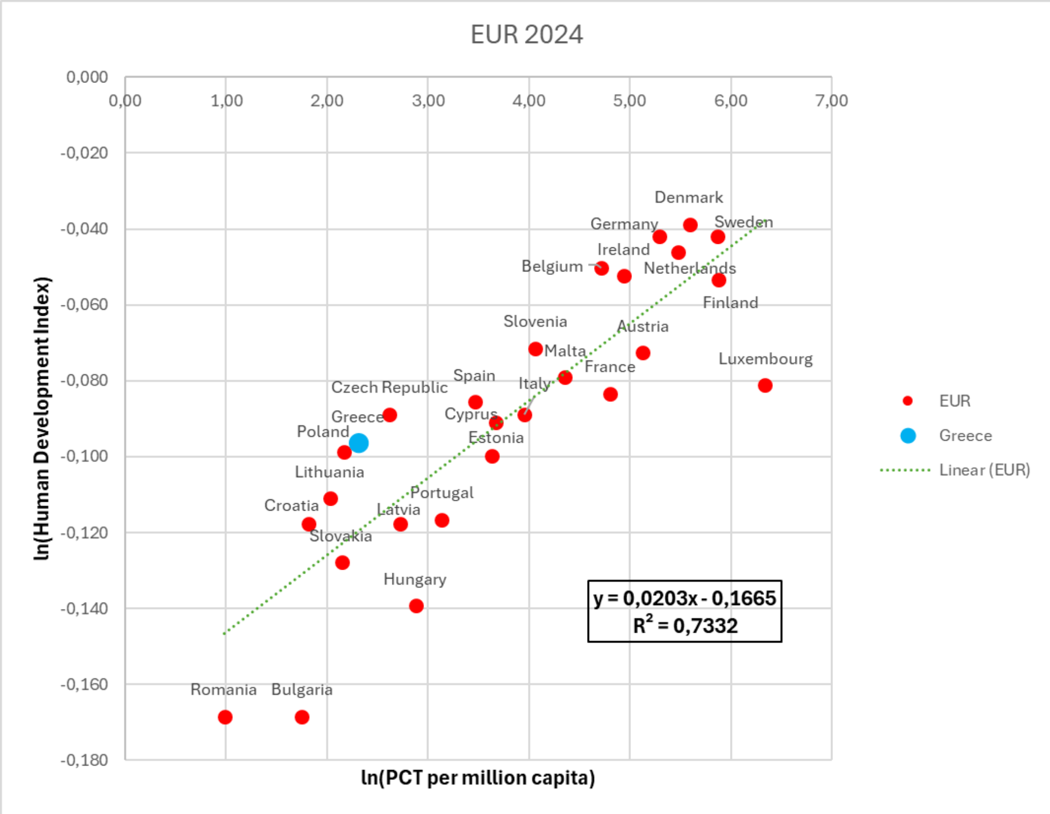

Figure 35. The log-log plot of HDI versus the PCT per capita of EUR

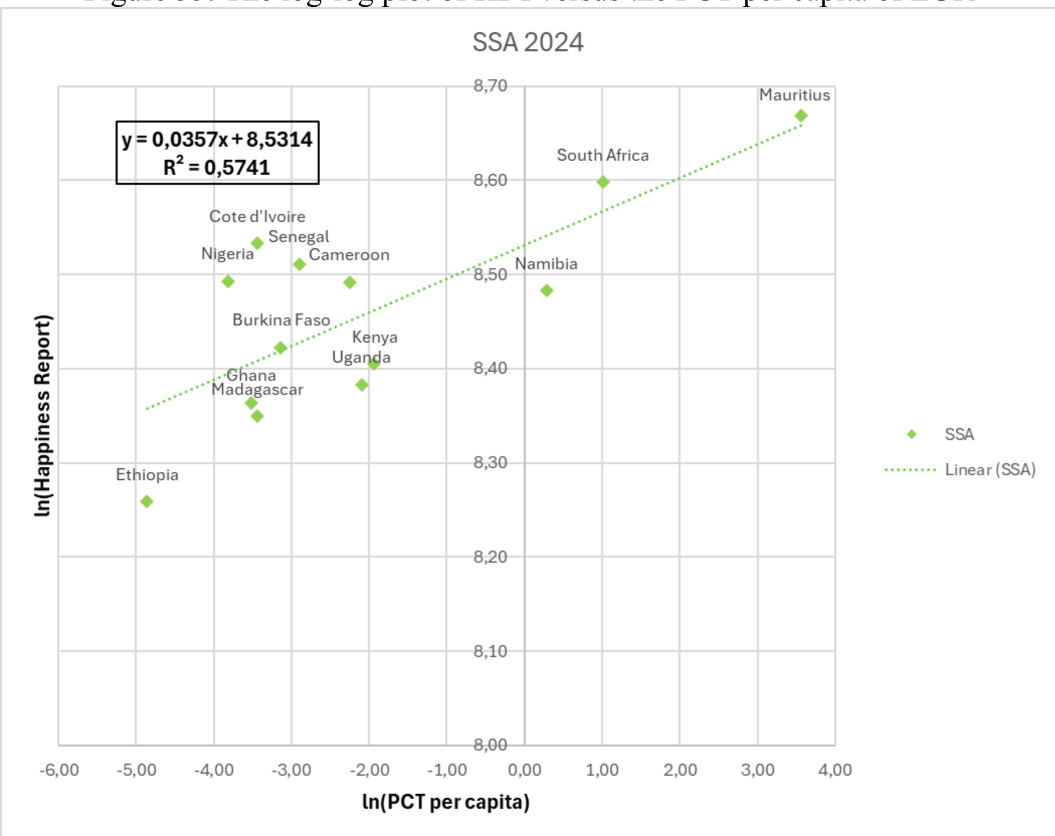

Figure 36. The log-log plot of Happiness Report versus the PCT per capita of SSA

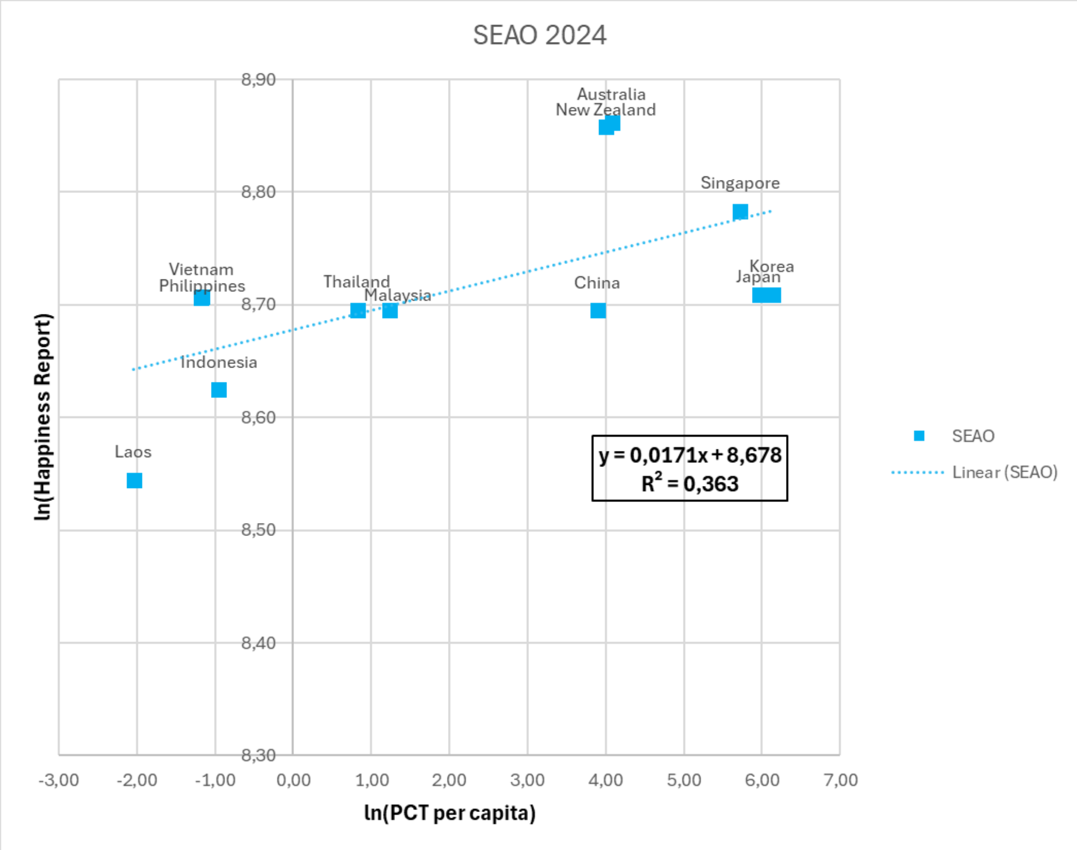

Figure 37. The log-log plot of Happiness Report versus PCT per capita of SEAO

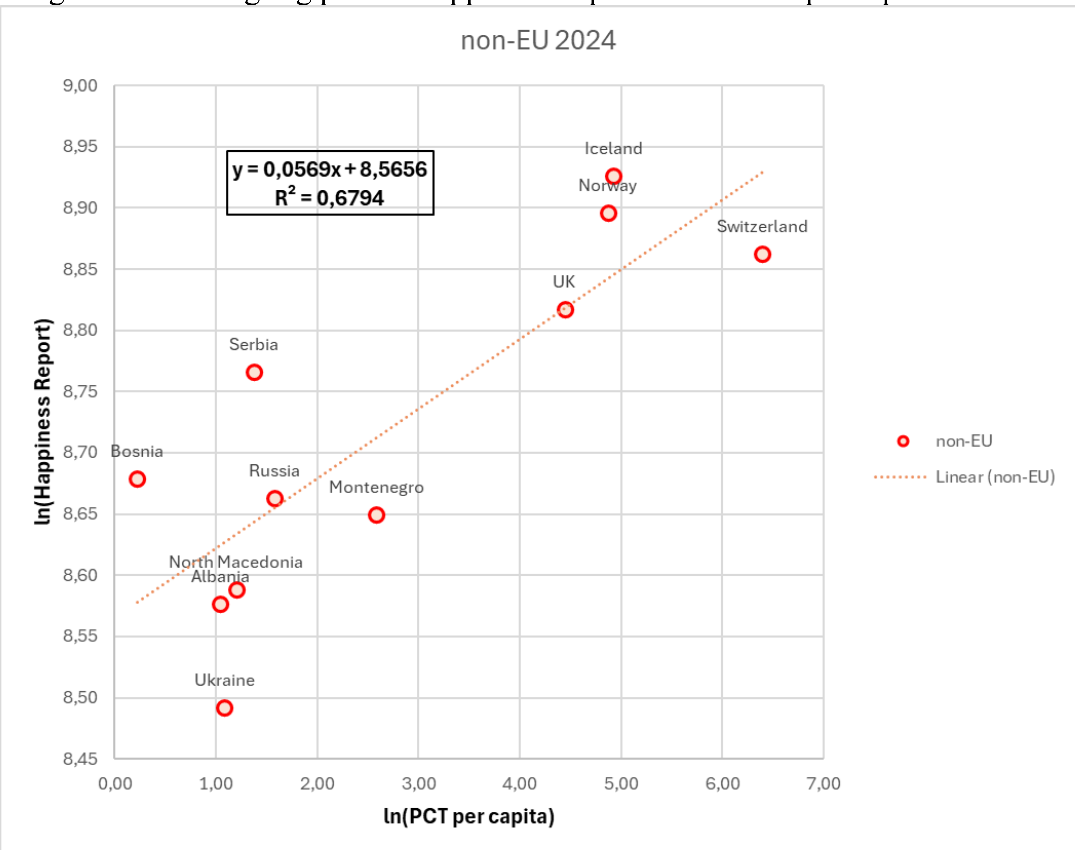

Figure 38. The log-log plot of Happiness Report versus PCT per capita of non-EU

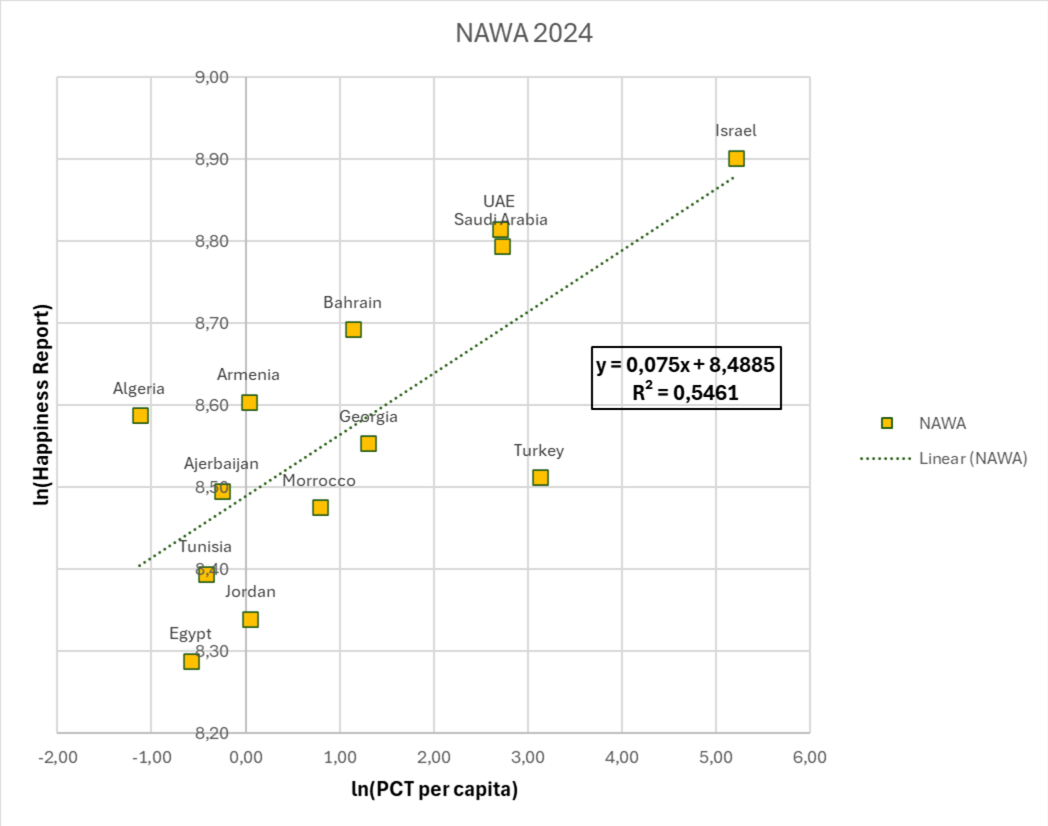

Figure 39. The log-log plot of Happiness Report versus PCT per capita of NAWA

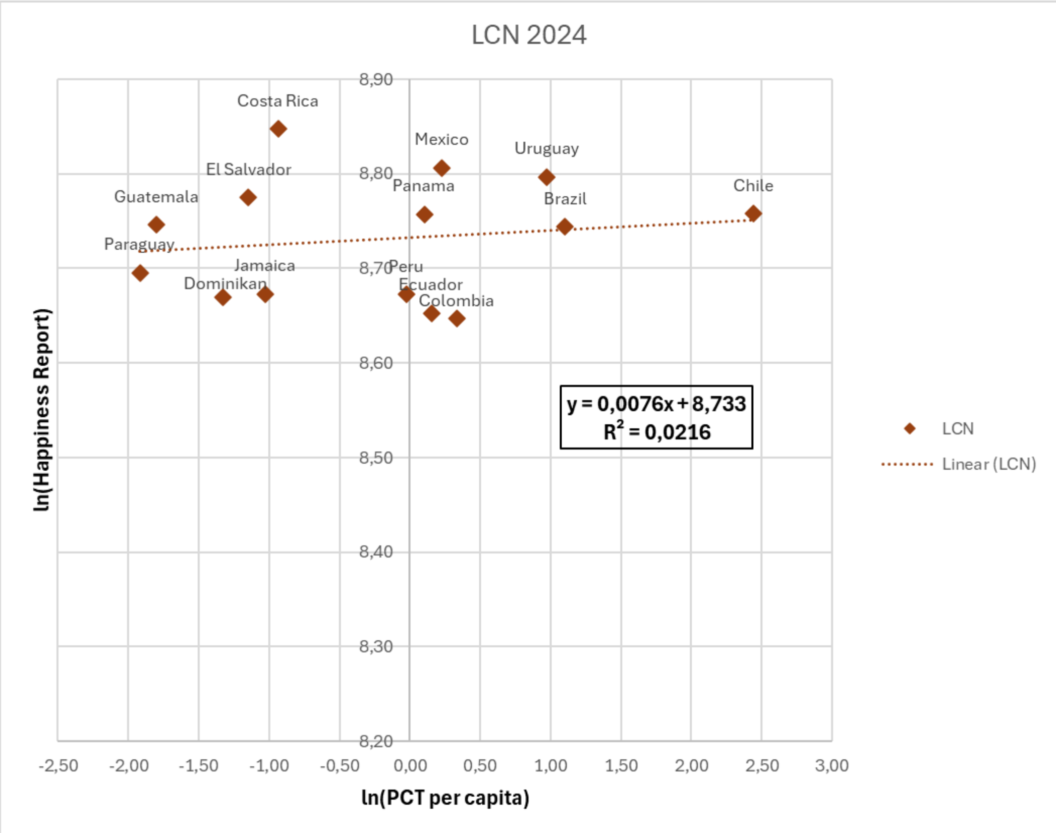

Figure 40. The log-log plot of Happiness Report versus PCT per capita of LCN

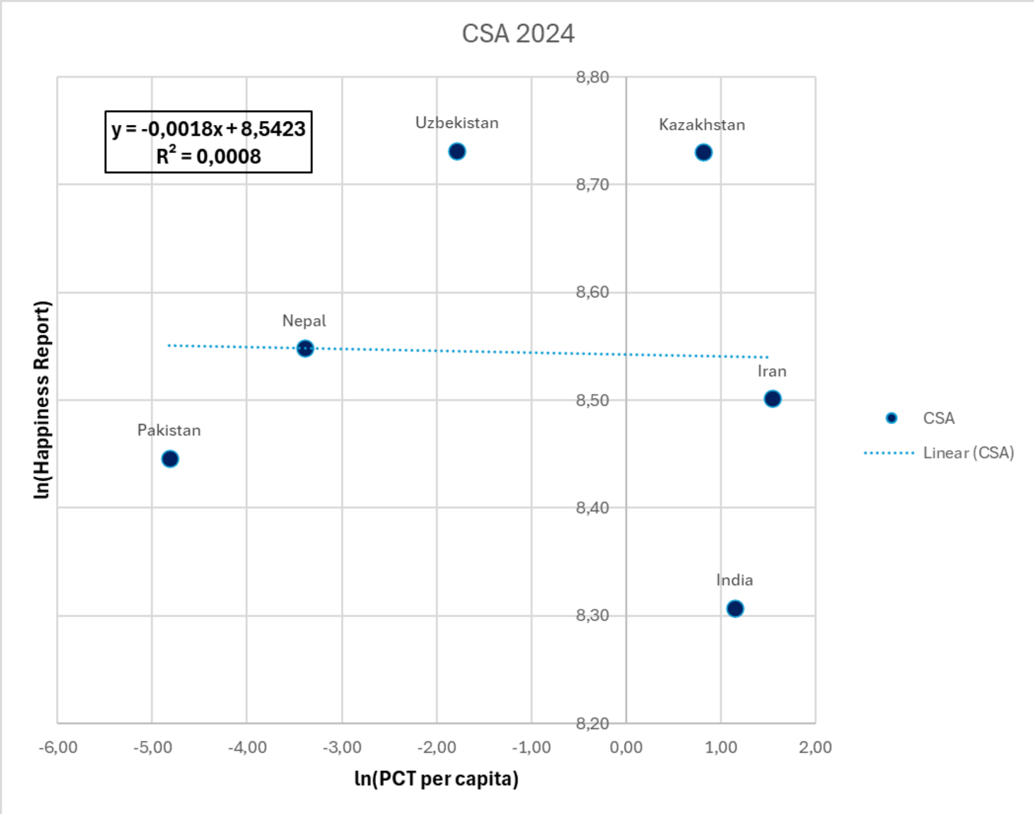

Figure 41. The log-log plot of Happiness Report versus PCT per capita of CSA

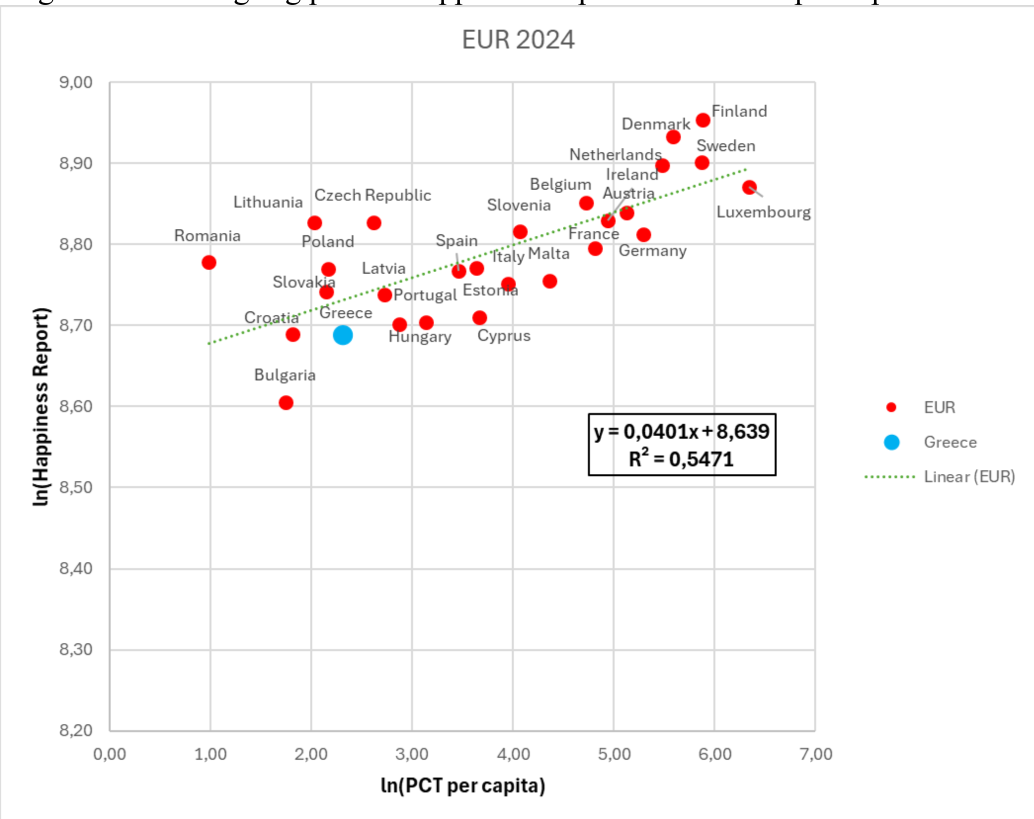

Figure 42. The log-log plot of Happiness Report versus PCT per capita of EUR

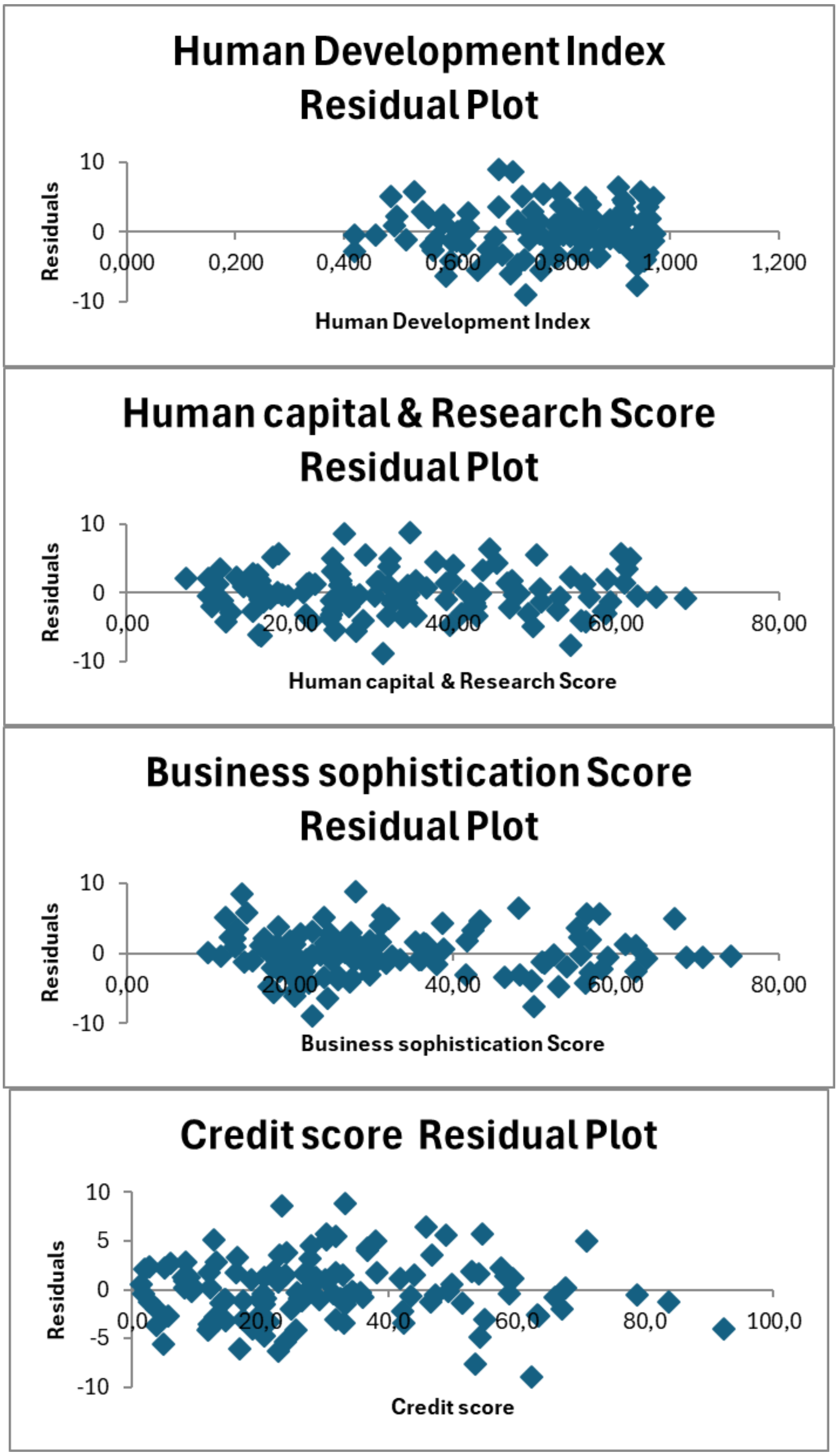

Figure 43. Residual plots of HDI, HCRS, BSS and CS for 120 countries around the globe

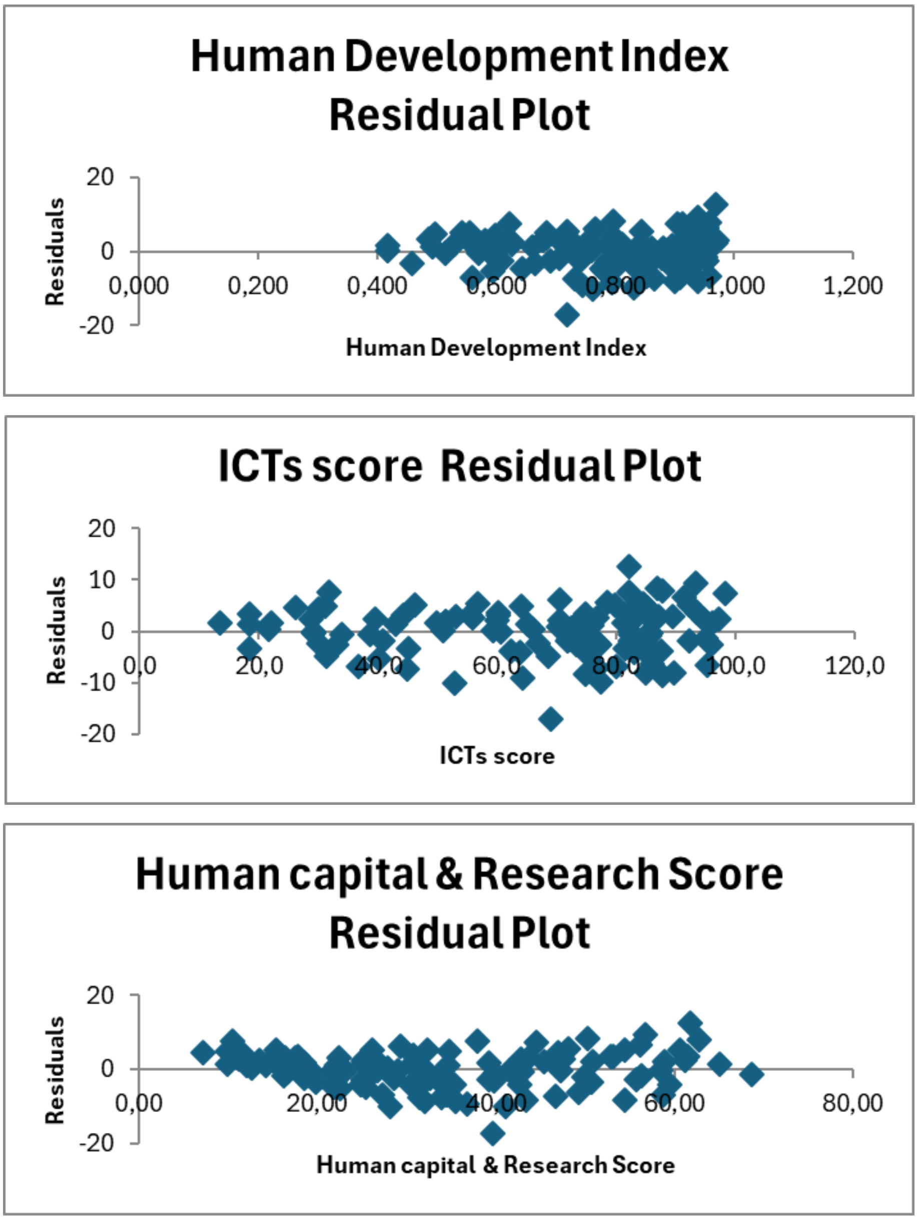

Figure 44. Residual plots of HDI, ICTS, and HCRS for 120 countries around the globe

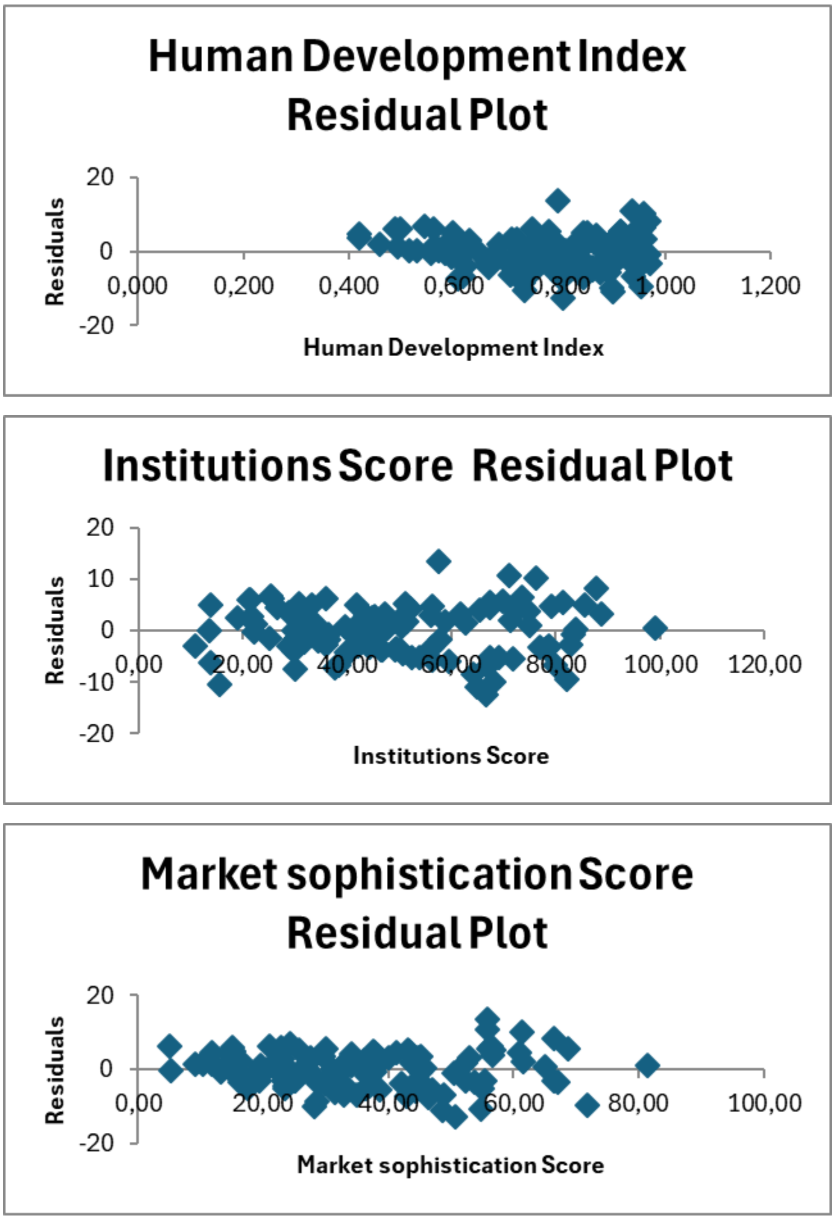

Figure 45. Residual plots of HDI, IS, and MSS for 120 countries around the globe

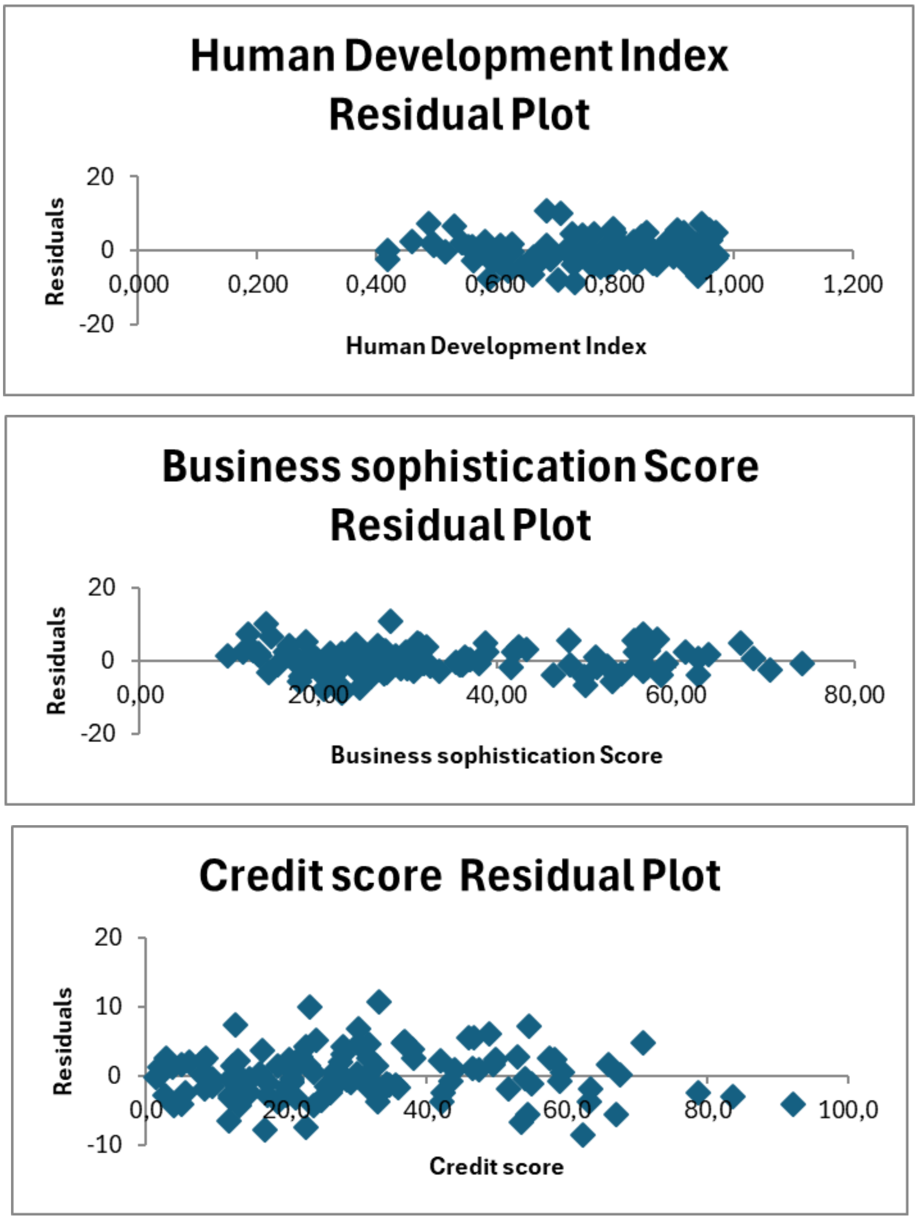

Figure 46. Residual plots of HDI, BSS and CS for 120 countries around the globe

Appendix B: "Tables"

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,895368652
R Square	0,801685024
Adjusted R Square	0,757615029
Standard Error	2,482964848
Observations	23

ANOVA

	df	SS	MS	F	Significance F
Regression	4	448,6027228	112,1506807	18,19117583	3,89777E-06
Residual	18	110,9720598	6,165114435		
Total	22	559,5747826			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	-6,017385509	3,326325625	-1,809018775	0,08718206	-13,00573633	0,97096531	-13,0057363	0,97096531
Human Development Index	35,43694006	9,348019891	3,790849877	0,001338404	15,79747903	55,07640108	15,79747903	55,07640108
Human capital & Research Score	0,121026105	0,126524408	0,956543542	0,351469526	-0,144791812	0,386844022	-0,14479181	0,386844022
Business sophistication Score	-0,023138135	0,156615912	-0,147738085	0,884191806	-0,352175956	0,305899686	-0,35217596	0,305899686
Credit score	0,099027794	0,064528968	1,534625417	0,142265729	-0,036542537	0,234598125	-0,03654254	0,234598125

Table 1. Multiple regression of GIS with HDI, HCRS, BSS and CS for Sub Saharan Africa (SSA) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,985838843
R Square	0,971878224
Adjusted R Square	0,961652124
Standard Error	2,970766798
Observations	16

ANOVA

	df	SS	MS	F	Significance F
Regression	4	3355,049366	838,7623415	95,03898738	1,8715E-08
Residual	11	97,08000906	8,825455369		
Total	15	3452,129375			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	7,107723542	9,532729358	0,745612644	0,471534148	-13,87367231	28,08911939	-13,8736723	28,08911939
Human Development Index	-2,615328459	17,45951922	-0,149793842	0,883638491	-41,04347116	35,81281425	-41,0434712	35,81281425
Human capital & Research Score	0,229215302	0,171658422	1,335298905	0,20875299	-0,148602336	0,607032941	-0,14860234	0,607032941
Business sophistication Score	0,58578696	0,128119933	4,572176594	0,000800521	0,303796888	0,867777032	0,303796888	0,867777032
Credit score	0,044542573	0,036035409	1,23607792	0,24217425	-0,034770827	0,123855973	-0,03477083	0,123855973

Table 2. Multiple regression of GIS with HDI, HCRS, BSS and CS for South East Asia and Oceania (SEAO) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,991984763
R Square	0,98403377
Adjusted R Square	0,973389616
Standard Error	2,453369526
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2225,793141	556,4482851	92,44828851	1,60855E-05
Residual	6	36,11413218	6,019022029		
Total	10	2261,907273			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	4,115023669	17,22853532	0,238849304	0,819171492	-38,04168359	46,27173093	-38,0416836	46,27173093
Human Development Index	-4,12069258	24,50532517	-0,168154985	0,87198638	-64,08306315	55,841678	-64,0830632	55,841678
Human capital & Research Score	0,280247274	0,158004061	1,773671338	0,126479727	-0,106374735	0,666869284	-0,10637474	0,666869284
Business sophistication Score	0,578892027	0,161822278	3,577332086	0,011680556	0,182927177	0,974856876	0,182927177	0,974856876
Credit score	0,152576319	0,078864012	1,934676094	0,101186049	-0,040396967	0,345549605	-0,04039697	0,345549605

Table 3. Multiple regression of GIS with HDI, HCRS, BSS and CS for European countries outside the Union (non-EU) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,949717579
R Square	0,90196348
Adjusted R Square	0,858391693
Standard Error	3,489142135
Observations	14

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	1008,04727	252,0118175	20,70063099	0,000146317
Residual	9	109,5670156	12,17411284		
Total	13	1117,614286			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	24,08520852	15,7127605	1,532843864	0,159679386	-11,45952519	59,62994223	-11,4595252	59,62994223
Human Development Index	-21,88987142	22,81028981	-0,959648983	0,362301689	-73,49033191	29,71058907	-73,4903319	29,71058907
Human capital & Research Score	0,065105607	0,206331435	0,315538962	0,759546542	-0,401648526	0,53185974	-0,40164853	0,53185974
Business sophistication Score	0,468458098	0,132728245	3,529452959	0,006419455	0,168205947	0,768710248	0,168205947	0,768710248
Credit score	0,323657502	0,115013264	2,814088494	0,020241451	0,063479424	0,583835581	0,063479424	0,583835581

Table 4. Multiple regression of GIS with HDI, HCRS, BSS and CS for Northen Africa and Western Asia (NAWA) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,917482745
R Square	0,841774588
Adjusted R Square	0,793089845
Standard Error	2,66326774
Observations	18

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	490,5605088	122,6401272	17,29031619	4,03927E-05
Residual	13	92,20893568	7,092995052		
Total	17	582,7694444			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-23,21342383	8,480321327	-2,737328332	0,01694304	-41,53404422	-4,89280344	-41,5340442	-4,89280344
Human Development Index	38,9197713	12,25322288	3,176288531	0,007293026	12,44829265	65,39124995	12,44829265	65,39124995
Human capital & Research Score	0,099668015	0,170284269	0,585303711	0,56836489	-0,268208783	0,467544812	-0,26820878	0,467544812
Business sophistication Score	0,572614966	0,176661494	3,241311686	0,00643495	0,190961011	0,954268921	0,190961011	0,954268921
Credit score	0,022141016	0,066764725	0,331627454	0,745456039	-0,122095403	0,166377434	-0,1220954	0,166377434

Table 5. Multiple regression of GIS with HDI, HCRS, BSS and CS for Latin America and Caribbean (LCN) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,759790974
R Square	0,577282324
Adjusted R Square	0,154564647
Standard Error	5,966110312
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	194,4376665	48,60941663	1,3656451	0,384999661
Residual	4	142,377889	35,59447226		
Total	8	336,8155556			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-2,222212864	22,77915633	-0,097554661	0,926978709	-65,46728996	61,02286424	-65,46729	61,02286424
Human Development Index	3,893624967	31,71006736	0,122788291	0,908196903	-84,14763634	91,93488628	-84,1476363	91,93488628
Human capital & Research Score	0,248361038	0,29161398	0,851677408	0,442379512	-0,561289168	1,058011245	-0,56128917	1,058011245
Business sophistication Score	0,706732001	0,473531819	1,49246993	0,209858972	-0,608003101	2,021467104	-0,6080031	2,021467104
Credit score	0,079112851	0,14042112	0,56339709	0,603248838	-0,310758682	0,468984383	-0,31075868	0,468984383

Table 6. Multiple regression of GIS with HDI, HCRS, BSS and CS for Central Southern Asia (CSA) countries

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,965203098
R Square	0,93161702
Adjusted R Square	0,919183751
Standard Error	2,47337944
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	1833,553412	458,388353	74,9293701	1,71987E-12
Residual	22	134,5873287	6,117605852		
Total	26	1968,140741			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-41,85941922	27,51259072	-1,521464106	0,142387665	-98,91704014	15,19820169	-98,9170401	15,19820169
Human Development Index	65,81427521	35,55622553	1,850991612	0,077643708	-7,924823318	139,5533737	-7,92482332	139,5533737
Human capital & Research Score	0,04043176	0,132538461	0,305056809	0,763190269	-0,234436185	0,315299705	-0,23443619	0,315299705
Business sophistication Score	0,358844716	0,07534827	4,762481137	9,37851E-05	0,202581968	0,515107465	0,202581968	0,515107465
Credit score	0,238862084	0,058817137	4,061096769	0,000519656	0,116882808	0,36084136	0,116882808	0,36084136

Table 7. Multiple regression of GIS with HDI, HCRS, BSS and CS for the 27 European Union countries (EUR)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,9369753
R Square	0,877922713
Adjusted R Square	0,858647352
Standard Error	1,89613695
Observations	23

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	491,2634113	163,7544704	45,54636916	7,16952E-09
Residual	19	68,31137136	3,595335335		
Total	22	559,5747826			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-1,597743063	2,782284955	-0,574255725	0,572531446	-7,4211324	4,225646273	-7,421132	4,225646273
Human Development Index	16,77474324	7,230301732	2,320061301	0,031623319	1,641547799	31,90793869	1,6415478	31,90793869
ICTs score	0,145135021	0,03619179	4,010164244	0,000748608	0,069384735	0,220885308	0,0693847	0,220885308
Human capital & Research Score	0,229181656	0,08525753	2,688110445	0,014557695	0,050735596	0,407627716	0,0507356	0,407627716

Table 8. Multiple regression of GIS with HDI, ICTS and HCRS for Sub Saharan Africa (SSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,979643853							
R Square	0,959702079							
Adjusted R Square	0,949627599							
Standard Error	3,404820548							
Observations	16							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	3313,015739	1104,33858	95,26070469	1,234E-08			
Residual	12	139,1136356	11,59280297					
Total	15	3452,129375						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	25,79614861	12,58669142	2,049478116	0,062929661	-1,627896133	53,22019335	-1,627896	53,22019335
Human Development Index	-60,67282185	27,69130924	-2,19104201	0,048916417	-121,0070017	-0,33864201	-121,007	-0,33864201
ICTs score	0,412418284	0,11763298	3,505974964	0,004333912	0,156118037	0,668718531	0,156118	0,668718531
Human capital & Research Score	0,789832852	0,142118107	5,557580728	0,00012426	0,480184097	1,099481607	0,4801841	1,099481607

Table 9. Multiple regression of GIS with HDI, ICTS and HCRS for South East Asia and Oceania (SEAO) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,96512658							
R Square	0,931469315							
Adjusted R Square	0,902099022							
Standard Error	4,705772349							
Observations	11							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	2106,897219	702,299073	31,71467521	0,000190861			
Residual	7	155,0100538	22,1442934					
Total	10	2261,907273						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-49,27083492	27,06070871	-1,820751831	0,111445711	-113,259243	14,71757316	-113,2592	14,71757316
Human Development Index	50,61164807	39,30398712	1,287697554	0,238785563	-42,32751306	143,5508092	-42,32751	143,5508092
ICTs score	0,166055379	0,215655595	0,770002646	0,466484073	-0,343889071	0,675999828	-0,343889	0,675999828
Human capital & Research Score	0,763478918	0,222057838	3,43819846	0,010863699	0,238395568	1,288562267	0,2383956	1,288562267

Table 10. Multiple regression of GIS with HDI, ICTS and HCRS for European countries outside the Union (non-EU) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,894528835							
R Square	0,800181836							
Adjusted R Square	0,740236387							
Standard Error	4,725670684							
Observations	14							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	894,2946516	298,0982172	13,34850016	0,000787148			
Residual	10	223,3196341	22,33196341					
Total	13	1117,614286						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	3,498539162	19,05950366	0,183558776	0,858028124	-38,96868144	45,96575976	-38,96868	45,96575976
Human Development Index	-30,52921172	38,14564367	-0,80033285	0,442116295	-115,5230024	54,46457898	-115,523	54,46457898
ICTs score	0,466280366	0,246622171	1,890666858	0,087965291	-0,083228076	1,015788808	-0,083228	1,015788808
Human capital & Research Score	0,532296433	0,204269761	2,605850367	0,026226885	0,077155041	0,987437825	0,077155	0,987437825

Table 11. Multiple regression of GIS with HDI, ICTS and HCRS for Northen Africa and Western Asia (NAWA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,907835056							
R Square	0,824164488							
Adjusted R Square	0,78648545							
Standard Error	2,705438483							
Observations	18							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	480,297881	160,0992937	21,87328891	1,50196E-05			
Residual	14	102,4715634	7,319397388					
Total	17	582,7694444						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	5,640273983	10,70782114	0,526743388	0,606617594	-17,32571825	28,60626622	-17,32572	28,60626622
Human Development Index	-6,469696504	19,61747656	-0,329792493	0,746439438	-48,54499908	35,60560607	-48,545	35,60560607
ICTs score	0,286662912	0,091011617	3,14973979	0,007095308	0,091462407	0,481863417	0,0914624	0,481863417
Human capital & Research Score	0,218828019	0,118841953	1,841336438	0,086857554	-0,036062621	0,473718658	-0,036063	0,473718658

Table 12. Multiple regression of GIS with HDI, ICTS and HCRS for Latin America and Caribbean (LCN) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,579671805							
R Square	0,336019401							
Adjusted R Square	-0,062368958							
Standard Error	6,687884481							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	113,1765614	37,72552046	0,843446837	0,526073483			
Residual	5	223,6389942	44,72779883					
Total	8	336,8155556						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	20,64857359	21,11509696	0,977905696	0,373032306	-33,6295111	74,92665828	-33,62951	74,92665828
Human Development Index	-13,27691637	38,64486133	-0,343562272	0,745150845	-112,6166949	86,06286221	-112,6167	86,06286221
ICTs score	0,070118155	0,167624533	0,418304851	0,693083363	-0,360774424	0,501010734	-0,360774	0,501010734
Human capital & Research Score	0,343821967	0,294148627	1,168871569	0,295145285	-0,41231115	1,099955084	-0,412311	1,099955084

Table 13. Multiple regression of GIS with HDI, ICTS and HCRS for Central Southern Asia (CSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,890340304							
R Square	0,792705857							
Adjusted R Square	0,765667491							
Standard Error	4,21170237							
Observations	27							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1560,156693	520,052231	29,31781618	4,91306E-08			
Residual	23	407,9840477	17,73843686					
Total	26	1968,140741						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-63,00694328	39,01963473	-1,614749695	0,120001494	-143,7252076	17,71132106	-143,7252	17,71132106
Human Development Index	64,30575727	50,17443696	1,281643824	0,212737931	-39,48797361	168,0994881	-39,48797	168,0994881
ICTs score	0,318595561	0,132636781	2,402015184	0,02477636	0,044215475	0,592975647	0,0442155	0,592975647
Human capital & Research Score	0,501233592	0,181456606	2,762278006	0,011088602	0,125862003	0,876605182	0,125862	0,876605182

Table 14. Multiple regression of GIS with HDI, ICTS and HCRS for the 27 European Union countries (EUR)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,946561336							
R Square	0,895978363							
Adjusted R Square	0,879553894							
Standard Error	1,750306516							
Observations	23							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	501,3668975	167,1222992	54,55143541	1,58157E-09			
Residual	19	58,2078851	3,0635729					
Total	22	559,5747826						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-2,536006442	2,468146724	-1,0274942	0,317091822	-7,701896905	2,62988402	-7,701896905	2,62988402
Human Development Index	24,42003619	5,827682352	4,190351278	0,000496118	12,22255685	36,61751554	12,22255685	36,61751554
Institutions Score	0,025390082	0,037562323	0,67594547	0,507220229	-0,053228763	0,104008926	-0,053228763	0,104008926
Market sophistication Score	0,255248396	0,048747939	5,236085943	4,7049E-05	0,153217788	0,357279004	0,153217788	0,357279004

Table 15. Multiple regression of GIS with HDI, IS and MSS for Sub Saharan Africa (SSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,925176852							
R Square	0,855952207							
Adjusted R Square	0,819940259							
Standard Error	6,437336521							
Observations	16							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	2954,857757	984,9525857	23,76856149	2,45277E-05			
Residual	12	497,2716179	41,43930149					
Total	15	3452,129375						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-39,61427158	15,26478151	-2,595141736	0,023434812	-72,87337337	-6,35516979	-72,87337337	-6,35516979
Human Development Index	81,10051805	28,96288681	2,800153126	0,016039693	17,99580868	144,2052274	17,99580868	144,2052274
Institutions Score	0,007558377	0,192222403	0,039321001	0,969281077	-0,41125826	0,426375015	-0,41125826	0,426375015
Market sophistication Score	0,287818147	0,196941936	1,461436571	0,169582635	-0,141281469	0,716917763	-0,141281469	0,716917763

Table 16. Multiple regression of GIS with HDI, IS and MSS for South East Asia and Oceania (SEAO) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,952559221							
R Square	0,907369069							
Adjusted R Square	0,867670099							
Standard Error	5,470995943							
Observations	11							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	2052,384696	684,1282322	22,85623683	0,000542518			
Residual	7	209,5225763	29,93179661					
Total	10	2261,907273						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-20,20301078	44,24378567	-0,456629343	0,661768909	-124,8229394	84,4169178	-124,8229394	84,4169178
Human Development Index	26,67441483	64,49869668	0,413565176	0,691568687	-125,8407675	179,1895972	-125,8407675	179,1895972
Institutions Score	0,253909944	0,173271535	1,465387511	0,186237442	-0,15581213	0,663632018	-0,15581213	0,663632018
Market sophistication Score	0,516735472	0,193692577	2,667812465	0,032101341	0,058725306	0,974745637	0,058725306	0,974745637

Table 17. Multiple regression of GIS with HDI, IS and MSS for European countries outside the Union (non-EU) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,928290554							
R Square	0,861723352							
Adjusted R Square	0,820240358							
Standard Error	3,931157043							
Observations	14							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	963,0743287	321,0247762	20,77293034	0,000128714			
Residual	10	154,539957	15,4539957					
Total	13	1117,614286						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-9,533036077	16,43292192	-0,580118139	0,574672698	-46,14786786	27,08179571	-46,14786786	27,08179571
Human Development Index	29,62406867	25,71509118	1,152011029	0,276113354	-27,67272508	86,92086242	-27,67272508	86,92086242
Institutions Score	-0,053831843	0,107661037	-0,500012305	0,627885246	-0,293715582	0,186051896	-0,293715582	0,186051896
Market sophistication Score	0,559389999	0,10934016	5,116052503	0,000453289	0,315764941	0,803015058	0,315764941	0,803015058

Table 18. Multiple regression of GIS with HDI, IS and MSS for Northen Africa and Western Asia (NAWA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,850622779							
R Square	0,723559113							
Adjusted R Square	0,66432178							
Standard Error	3,392231696							
Observations	18							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	421,6681422	140,5560474	12,2145795	0,000337455			
Residual	14	161,1013023	11,50723588					
Total	17	582,7694444						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-19,87235822	9,692344732	-2,050314838	0,059544945	-40,66037017	0,915653736	-40,66037017	0,915653736
Human Development Index	41,5339209	14,87340825	2,792495184	0,014391299	9,633632882	73,43420891	9,633632882	73,43420891
Institutions Score	0,161571116	0,072629471	2,224594431	0,043065391	0,005796394	0,317345838	0,005796394	0,317345838
Market sophistication Score	0,211573602	0,093619895	2,259921369	0,040292588	0,010778897	0,412368307	0,010778897	0,412368307

Table 19. Multiple regression of GIS with HDI, IS and MSS for Latin America and Caribbean (LCN) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,921912129							
R Square	0,849921974							
Adjusted R Square	0,759875158							
Standard Error	3,17957902							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	286,2669418	95,42231394	9,438667739	0,016793127			
Residual	5	50,54861373	10,10972275					
Total	8	336,8155556						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,027986345	9,310852462	0,003005777	0,997717978	-23,90632187	23,96229456	-23,90632187	23,96229456
Human Development Index	2,565580902	13,39601959	0,191518151	0,855654203	-31,86998372	37,00114552	-31,86998372	37,00114552
Institutions Score	0,242269145	0,087809889	2,759018923	0,039881051	0,01654664	0,467991651	0,01654664	0,467991651
Market sophistication Score	0,432396379	0,094540171	4,573678824	0,00598181	0,189373132	0,675419625	0,189373132	0,675419625

Table 20. Multiple regression of GIS with HDI, IS and MSS for Central Southern Asia (CSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,954402056							
R Square	0,910883285							
Adjusted R Square	0,899259365							
Standard Error	2,761491707							
Observations	27							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1792,746502	597,5821675	78,36283554	3,18068E-12			
Residual	23	175,3942383	7,625836449					
Total	26	1968,140741						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-83,78927015	21,22902943	-3,946919497	0,00064175	-127,7048634	-39,8736769	-127,7048634	-39,87367687
Human Development Index	114,4906754	26,22768513	4,365260405	0,000226535	60,23457497	168,7467759	60,23457497	168,7467759
Institutions Score	0,082486148	0,069917892	1,179757372	0,250155882	-0,062150031	0,227122328	-0,062150031	0,227122328
Market sophistication Score	0,453448524	0,07128857	6,360746542	1,72139E-06	0,305976881	0,600920166	0,305976881	0,600920166

Table 21. Multiple regression of GIS with HDI, IS and MSS for the 27 European Union countries (EUR)

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,889721463							
R Square	0,791604282							
Adjusted R Square	0,758699695							
Standard Error	2,47740302							
Observations	23							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	442,9617938	147,6539313	24,05756617	1,10136E-06			
Residual	19	116,6129888	6,137525726					
Total	22	559,5747826						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-6,734778048	3,233414585	-2,082868704	0,051013503	-13,50239255	0,032836457	-13,50239255	0,032836
Human Development Index	39,34879289	8,387173457	4,69154395	0,000158927	21,7942371	56,90334869	21,7942371	56,90335
Business sophistication Score	-0,011445517	0,155788402	-0,073468353	0,942201372	-0,33751439	0,314623355	-0,33751439	0,314623
Credit score	0,128162903	0,056760645	2,257953604	0,035907615	0,009361508	0,246964299	0,009361508	0,246964

Table 22. Multiple regression of GIS with HDI, BSS and CS for Sub Saharan Africa (SSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,983524215							
R Square	0,967319881							
Adjusted R Square	0,959149851							
Standard Error	3,066159384							
Observations	16							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	3339,313375	1113,104458	118,3985733	3,52198E-09			
Residual	12	112,8160004	9,401333369					
Total	15	3452,129375						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-0,037923889	8,14229927	-0,004657639	0,99636029	-17,77847	17,70262222	-17,77847	17,70262
Human Development Index	10,85829294	14,70602815	0,738356599	0,47449122	-21,18338987	42,89997574	-21,18338987	42,89998
Business sophistication Score	0,702484818	0,096693427	7,265073128	9,93948E-06	0,491807939	0,913161697	0,491807939	0,913162
Credit score	0,059388078	0,035378159	1,678665025	0,119046005	-0,017694308	0,136470464	-0,017694308	0,13647

Table 23. Multiple regression of GIS with HDI, BSS and CS for South East Asia and Oceania (SEAO) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,987756236							
R Square	0,975662383							
Adjusted R Square	0,965231975							
Standard Error	2,804318961							
Observations	11							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	2206,857839	735,6192796	93,54019828	5,18614E-06			
Residual	7	55,04943385	7,864204836					
Total	10	2261,907273						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	3,234047636	19,68485592	0,164291151	0,874145257	-43,31324005	49,78133533	-43,31324005	49,78134
Human Development Index	1,894310789	27,74123945	0,068285009	0,947468362	-63,70329679	67,49191837	-63,70329679	67,49192
Business sophistication Score	0,723706416	0,159700888	4,531636765	0,002694442	0,346073823	1,101339008	0,346073823	1,101339
Credit score	0,196765587	0,085528896	2,30057438	0,054944571	-0,005478115	0,39900929	-0,005478115	0,399009

Table 24. Multiple regression of GIS with HDI, BSS and CS for European countries outside the Union (non-EU) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,949146419							
R Square	0,900878925							
Adjusted R Square	0,871142603							
Standard Error	3,328349878							
Observations	14							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1006,835157	335,6117189	30,29557296	2,48079E-05			
Residual	10	110,7791291	11,07791291					
Total	13	1117,614286						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	24,33369769	14,96982289	1,625516739	0,135113523	-9,021146303	57,68854169	-9,021146303	57,68854
Human Development Index	-21,04691832	21,6093661	-0,973972037	0,353041128	-69,1955865	27,10174985	-69,1955865	27,10175
Business sophistication Score	0,493717349	0,100991788	4,888688076	0,000633701	0,268693623	0,718741075	0,268693623	0,718741
Credit score	0,343836784	0,091188715	3,770606728	0,003657898	0,140655664	0,547017904	0,140655664	0,547018

Table 25. Multiple regression of GIS with HDI, BSS and CS for Northen Africa and Western Asia (NAWA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,915207614							
R Square	0,837604978							
Adjusted R Square	0,802806044							
Standard Error	2,5999843							
Observations	18							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	488,1305874	162,7101958	24,06984629	8,6681E-06			
Residual	14	94,63885701	6,759918358					
Total	17	582,7694444						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-25,81245375	7,053143894	-3,659708937	0,002574832	-40,93994288	-10,6849646	-40,93994288	-10,685
Human Development Index	42,75525626	10,10771692	4,229961781	0,000840186	21,07635957	64,43415295	21,07635957	64,43415
Business sophistication Score	0,634327882	0,138378939	4,583991511	0,000425227	0,337534576	0,931121189	0,337534576	0,931121
Credit score	0,048496493	0,048123136	1,007758381	0,33067158	-0,054717367	0,151710354	-0,054717367	0,15171

Table 26. Multiple regression of GIS with HDI, BSS and CS for Latin America and Caribbean (LCN) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,707550204							
R Square	0,500627291							
Adjusted R Square	0,201003666							
Standard Error	5,799939592							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	168,6190592	56,20635308	1,670853861	0,286995218			
Residual	5	168,1964963	33,63929927					
Total	8	336,8155556						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-10,44826609	20,05548809	-0,520967929	0,624630411	-62,00253948	41,10600729	-62,00253948	41,10601
Human Development Index	21,03928371	23,8175288	0,883352924	0,417488891	-40,1856232	82,26419063	-40,1856232	82,26419
Business sophistication Score	0,862381955	0,424676391	2,030680238	0,098026138	-0,229283462	1,954047371	-0,229283462	1,954047
Credit score	0,045690855	0,131070994	0,348596236	0,741590993	-0,29123786	0,38261957	-0,29123786	0,38262

Table 27. Multiple regression of GIS with HDI, BSS and CS for Central Southern Asia (CSA) countries

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,965053243							
R Square	0,931327761							
Adjusted R Square	0,922370513							
Standard Error	2,424123607							
Observations	27							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1832,98411	610,9947032	103,9747593	1,60465E-13			
Residual	23	135,156631	5,876375263					
Total	26	1968,140741						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Ipper 95,0%*
Intercept	-47,60392182	19,65893497	-2,421490375	0,023748919	-88,27152726	-6,93631638	-88,27152726	-6,93632
Human Development Index	73,7028589	23,91764366	3,081526757	0,005273253	24,22544333	123,1802745	24,22544333	123,1803
Business sophistication Score	0,360147712	0,073729006	4,884749353	6,20884E-05	0,207627644	0,51266778	0,207627644	0,512668
Credit score	0,248663855	0,048284079	5,150017528	3,21776E-05	0,148780627	0,348547083	0,148780627	0,348547

Table 28. Multiple regression of GIS with HDI, BS and CS for the 27 European Union countries (EUR)

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