

ANALYSIS OF DIGITAL TRANSFORMATION AND ITS IMPACT ON THE SUSTAINABLE ECONOMIC DEVELOPMENT OF SOUTH KOREA

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Abstract. *This study examines the impact of digital transformation on sustainable economic development in South Korea by using a regression model to analyze key economic variables. By examining the impact of Internet use, R&D spending, and ICT service exports on South Korea's GDP, the study quantifies the positive relationship between these factors and economic growth. The analysis shows that increased internet users stimulate innovation and economic activity, leading to higher GDP. Similarly, high R&D investment promotes technological progress and economic competitiveness. Exports of ICT services also show a positive correlation with GDP growth, serving as a proxy for economic activity. These findings provide valuable guidance for policymakers aiming to promote sustainable economic growth by improving digital infrastructure, research and ICT services.*

Keywords. *Digital transformation, econometric evaluation, gross domestic product, R&D, expenditure, ICT service exports, multivariate regression analysis, technological innovation.*

АНАЛИЗ ЦИФРОВОЙ ТРАНСФОРМАЦИИ И ЕЕ ВЛИЯНИЕ НА УСТОЙЧИВОЕ ЭКОНОМИЧЕСКОЕ РАЗВИТИЕ ЮЖНОЙ КОРЕИ

Аннотация. *В этом исследовании рассматривается влияние цифровой трансформации на устойчивое экономическое развитие в Южной Корее с использованием регрессионной модели для анализа ключевых экономических переменных. Изучая влияние использования Интернета, расходов на НИОКР и экспорта услуг ИКТ на ВВП Южной Кореи, исследование дает количественную оценку положительной связи между этими факторами и экономическим ростом. Анализ показывает, что увеличение числа пользователей Интернета стимулирует инновации и экономическую активность, что приводит к росту ВВП. Аналогичным образом, высокие инвестиции в НИОКР способствуют технологическому прогрессу и экономической конкурентоспособности. Экспорт услуг ИКТ также демонстрирует положительную корреляцию с ростом ВВП, что служит показателем экономической активности. Эти результаты служат ценным*

руководством для политиков, стремящихся способствовать устойчивому экономическому росту путем улучшения цифровой инфраструктуры, исследований и услуг ИКТ.

Ключевые слова. *Цифровая трансформация, эконометрическая оценка, валовой внутренний продукт, НИОКР, расходы, экспорт услуг ИКТ, многомерный регрессионный анализ, технологические инновации.*

The 21st century has witnessed an unprecedented revolution in technological development, driven by the ubiquity of digital technologies. This phenomenon, known as digital transformation, has profoundly changed our lives, including the global economy. Its impact is evident in everything from finance and manufacturing to health and education, driving innovation, improving productivity and reshaping the competitive environment.

The rapid pace of technological innovation has unleashed a wave of digital transformation that is fundamentally changing how businesses operate, how industries evolve, and the economy. From automating manual tasks to creating new business models, digital technologies are dramatically increasing productivity, driving innovation and reshaping the competitive landscape across all sectors. The rise of e-commerce platforms, the integration of artificial intelligence, and the proliferation of big data analytics are just a few examples of how digitization is changing the way we work, consume, and interact with the world around us.

In particular, the implementation of more than 220 priority projects aimed at improving the electronic government system, further developing the local market of software products and information technologies, establishing IT parks in all regions of the republic, as well as providing the sector with qualified personnel has begun.

Digital transformation plays a crucial role in promoting sustainable development by using technology to solve economic, social and environmental challenges. It enables the creation of smarter, more efficient systems and processes, fosters innovation and improves resource management. By implementing digital technologies, organizations and governments can optimize energy use, reduce emissions, and increase the efficiency of transportation and industrial processes. This helps to significantly reduce greenhouse gas emissions and other environmental impacts.

In the social sphere, digital transformation will expand access to education, healthcare and other essential services. By bridging the digital divide, it ensures that more people have access to these services, thereby promoting greater social equity and inclusion. E-learning platforms,

telemedicine, and digital financial services are examples of how technology can improve quality of life and empower disadvantaged populations.

Economic development is also accelerated by digital transformation. It enables data-driven decision-making and automation, improving efficiency in industries ranging from agriculture to manufacturing. Small and medium-sized enterprises (SMEs) use digital tools to compete in global markets, reach new customers and streamline operations. This leads to job creation, economic diversification and resilience to market changes.

In addition, digital transformation helps improve governance and transparency. E-governance initiatives improve the delivery of public services, make them more accessible and reduce corruption. The use of big data and analytics enables economists to make informed decisions based on real-time data, leading to more efficient and sustainable economic and policy outcomes.

Digital transformation has had a profound impact on South Korea's economy, cementing its position as a world leader in technology and innovation. By adopting digital technologies, South Korea has significantly improved its economic efficiency and competitiveness. The widespread use of high-speed internet and advanced mobile networks, combined with government initiatives such as the Digital New Deal, have fueled the development of the digital ecosystem. This has led to the emergence of new industries such as fintech, smart manufacturing and e-commerce, which have fueled economic growth and job creation. In addition, the integration of digital technologies into traditional sectors, including health, education and public services, is increasing efficiency and accessibility, contributing to overall economic development. The country's commitment to supporting the digital economy has also attracted significant foreign investment, further enhancing its economic stability and positioning South Korea as a global model of digital transformation.

However, while South Korea has made significant progress in creating a digital transformation environment, it faces challenges such as rapid data exchange, changing economic conditions, and cyber security. This study aims to examine the impact on South Korea's GDP and sustainable economic development by analyzing key variables such as the number of Internet users, R&D spending, and ICT service exports. By understanding the relationship between these factors and GDP, we can better understand the complexities involved in maintaining a stable and prosperous economic environment in South Korea.

When it comes to digital transformation, the opinions and approaches of scientists are very important. Vial defines digital transformation in 2019 as “The process of improving an object by making significant changes to its characteristics through a combination of information, computing, communication and connectivity technologies”. This approach emphasizes the role of new

technologies in driving transformation, focusing on how these technologies create new business models, processes and customer experiences. This definition is found in the article “Understanding Digital Transformation: A Review and Research Agenda” published in Strategic Information Systems [1].

Hess et al. 2016 describes digital transformation as involving “Fundamental transformation of business processes, operations and value propositions through the use of digital technologies”. Their approach focuses on transforming business processes and operations, including re-engineering more efficient and customer-centric processes using digital tools. This definition is found in their article “How German media companies defined their digital transformation strategies” published in MIS Quarterly Executive [2].

In a 2015 paper, Kane et al see digital transformation as “The process by which digital technologies create disruption, drive strategic responses by organizations to change the way they create value while managing structural changes and organizational barriers”. This approach emphasizes understanding and responding to digital disruption by focusing on customer needs and experiences, requiring organizations to be agile and responsive to changing customer expectations and market conditions. This perspective was published in the MIT Sloan Management Review in an article titled “Strategy, Not Technology, Drives Digital Transformation” [3].

Collectively, these approaches suggest that digital transformation involves not only the adoption of new technologies, but also significant strategic, operational, and cultural shifts within organizations to create value and maintain competitiveness in the digital economy.

To examine the impact of digital transformation on sustainable economic development in South Korea, this study uses a quantitative research methodology using a regression model to analyze the relationship between GDP and several key economic variables. The methodology includes the following steps:

Variables: the dependent variable in the regression model is the country's GDP amount (Y) [4], and the independent variables are:

People who use the Internet: as a percentage of the total population.

Research and development (R&D) costs: as a percentage of GDP.

Export of ICT services: reflected in the percentage of services exports.

Data for this study were obtained from authoritative international and national databases, including the World Bank and South Korea's National Bureau of Statistics [5]. These sources provide reliable and up-to-date data on economic indicators and South Korea's GDP growth. This can inform policymakers in developing targeted strategies to stimulate economic development through investment in internet infrastructure, R&D and ICT services.

Building an econometric model

Regression Analysis: The study uses a multiple linear regression model to examine the impact of independent variables on South Korea's GDP. The regression equation is defined as:

$$\text{GDP} = b_0 + b_1 * \text{People using the Internet} + b_2 * \text{Research and development (R\&D) expenses} + b_3 * \text{Export of ICT services}$$

Results

First, the problem of multicollinearity between selected variables is considered.

VIF test:

```
## x1 x2 x3
## 3.340957 8.564068 4.404186
```

We also use the OLSRR library `k <- ols_step_best_subset (lm(y~x1+x2+x3, data = dat));`

k

The function ranks the independent variables that best explain the model equation.

```
##Best subsets regression
## -----
##Model index predictors
## -----
## 1 x2
## 2 x1 x2
## 3 x1 x2 x3
## -----
```

It can be seen that we are told that the best indicator should be internet users and research and development (R&D) expenditure, but since the above vif model does not include research and development (R&D) expenditure (because the index is higher than 5 and there is a problem of multicollinearity), in the next step we construct another model excluding research and development (R&D) costs.

```
## x1 x3
## 1.311679 1.311679
```

As a result of the repeated VIF test, we confirmed that the problem of multicollinearity was eliminated because the VIF values of X1, X3 were less than 5.

In this case, we construct a bivariate regression equation $y=Y(X1, X3)$ involving two variables:

$$GDP(Y)=253,170 + 9,358* \text{Internet users} + 66,182* \text{ICT services export}$$

$$b_0 = b_1 = 4.57e-08 \quad b_2 = 3.94e-06$$

F-test results:

$F_{stat} = 89.2627 > F_{crit} = 3.68232$, so H_0 hypothesized, H_1 the hypothesis is accepted.

$H_0: \beta_1 = \beta_2 = 0$

$H_1: \beta_1 > 0$ because b_1 or $b_2 \neq 0$

Or

```
##F-statistics: 93.14 on 2 and 24 DF,p-value: 4.884e-12
```

P value=4.884e-12 Since $\alpha=0.05$ H_1 the hypothesis is accepted.

Economic conclusion on the «F» test: It shows that the amount of GDP in South Korea can be represented by the number of people using the Internet and the export of ICT services.

T-test results:

Hypothesis:

$H_0: \beta_1 = \beta_2 = 0$

$H_1: \beta_1 > 0$ because b_1 or $b_2 \neq 0$, there is a linear relationship between Y and X_i .

```
##coefficients:
## Estimated Std. Error t value Pr(>|t|)
##(Intercept)253.170 80.460 3.147 0.00437 **
## x1 9.358 1.195 7.833 4.57e-08 ***
## x3 66.182 11.140 5.941 3.94e-06 ***
```

Tstat for $b_1 = 7.833$ Tstat = for $b_2 5.941$

$$T_{crit} = T_{\frac{\alpha}{2}(n-k-1)} = 1.713872$$

```
alpha =0.1
Tcr <- qt(1-alpha/2, etc.1); Tcr
## [1] 1.713872
```

“T” test result: for x_1 $T_{stat} = 7.833 > T_{crit} = 1.713872$, so H_0 hypothesis is rejected, H_1 the hypothesis is accepted. for x_3 $T_{stat} = 5.941 > T_{crit} = 1.713872$, so H_0 hypothesis is rejected, H_1 the hypothesis is accepted.

hypothesis is accepted.

Economic conclusion on the “T” test: In Korea, there is a linear relationship between the predictors of the country's Internet users and ICT service exports with changes in GDP, which means that a regression analysis with 95% accuracy is appropriate in this case.

The regression equation

$$\text{GDP}(Y)=253,170 + 9,358* \text{Internet users} + 66,182* \text{ICT services export}$$

A brief description of the regression model:

Residual standard error: 157.1 24degrees of freedom

##Multiple R-squared: 0.8859, Adjusted R-squared: 0.8764

##F-statistics: 93.14 on 2 and 24 DF,p-value: 4.884e-12

After conducting VIF, F and T tests in the regression model, the remaining predictors: x_1 = “Internet users” and x_3 = “Export of ICT services” are linearly related to the variable Y = “Korea GDP” and this model is fit with 88% accuracy. The increase or decrease of GDP in the country may depend not only on the studied variables, but also on other factors. Therefore, the variables of our model, i.e. Internet users and ICT services exports, are explained on average. This model can be further refined by adding new variables depending on the field of study.

As a result of the above regression analysis, we can conclude from the economic point of view that both the share of Internet users and the share of ICT service exports are important factors of Korea's GDP. The model explains a significant part of the variance in GDP and shows that improving internet infrastructure and increasing exports of ICT services can be effective strategies for economic growth. Given the high importance of both variables, economists should focus on expanding Internet access and supporting the ICT sector to sustain and enhance economic growth in Korea.

Digital transformation will have a profound impact on the sustainable economic development of South Korea, and will increase the country's position as a world leader in the field of technology and innovation. Increased internet usage stimulates innovation and economic activity and has a positive impact on GDP growth. A large investment in research and development increases technological progress and economic competitiveness. In addition, ICT services exports show a positive correlation with GDP growth, indicating their role as a vital economic activity.

South Korea's commitment to digital transformation, such as initiatives such as the Digital New Deal and the widespread adoption of high-speed Internet and advanced mobile networks, has led to the emergence of new industries such as fintech, smart manufacturing, and e-commerce.

The integration of digital technologies into traditional sectors such as health and education has increased efficiency and accessibility, further contributing to economic growth.

Despite these advances, South Korea faces challenges such as rapid data exchange, evolving economic conditions, and cyber security threats. Understanding the relationship between key variables such as Internet use, R&D spending, and ICT service exports and their impact on GDP provides valuable insights for policymakers. These insights can help design targeted strategies to ensure sustainable economic growth by improving digital infrastructure, research and development, and ICT services.

In general, digital transformation is essential to promote sustainable economic growth by stimulating innovation, improving efficiency and optimizing resource management. It increases access to essential services, ensures social equity and accelerates economic development. The findings of this study provide important guidance to economists on how to support sustainable economic growth in South Korea through continued investment in digital infrastructure, research and development, and ICT services.

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