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Endogenous Economic Growth in the Digital Age: A Neo-Solow-Romer Analysis of the Impact of Technology on the Transformation of the Labor Market

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Abstract: The author addressed the Solow model, which is the basis for many studies on economic growth in the digital age, highlighting the role of physical and technological capital accumulation. In the digital age, endogenous economic growth, analyzed through the lens of neo-Solow-Romer, emphasized the technological impact on the transformation of the labor market. The Solow model shows that diminishing returns on capital limit economic growth, and exogenous technological progress becomes the main driver of economic development in the digital age. Modern theories integrate investments in research and development (R&D) and education, which stimulate technological progress and maintain long-term economic growth in the digital age. Thus, the technological impact has not been passive in the digital age, but the result of essential actions for competitiveness and sustainable productivity in the labor market. Endogenous economic growth in the digital age has reflected a new paradigm, in which technology and human capital have been the central pillars of economic development and labor market transformation. In the digital age, the labor market in the Republic of Moldova is changing rapidly, with advanced technologies enabling the storage, processing, and presentation of information necessary for various occupations. Although many employees have digital skills, current jobs often require additional training to meet requirements, which has led to the transformation of the labor market. This transformation depends on the capacity of human and physical capital, and the field of activity. Exogenous economic growth in this era effectively integrates automation and digitization, thus adapting employees' occupations to new technological realities. The author highlights, based on a questionnaire conducted among a group of people, that in the digital age, technology plays an important role in managing employees' work. Thus, digital activities have enabled employees to better organize their work, offering them more flexibility and increasing productivity.

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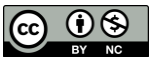

However, this transformation has brought with it a significant risk, such as technical unemployment, caused by the replacement of traditional occupations through automation and digitization.

Keywords: human capital; physical capital; technological progress; economic growth; research and development

JEL Classification: B21, B22, C3

1. Introduction

In the context of the digital age, analyzing economic growth is of major importance, as resources are increasingly limited and demands are constantly growing. Changes in the labor market require the efficient management of factors involved in digital work, which contribute to the adaptation and consolidation of economic growth. This highlights the importance of workforce training, job digitization, increasing the speed of circulation of current assets, and diversifying sales markets. Some researchers have pointed out that "modern economic growth is based, in particular, on increasing factor productivity, i.e., the efficient use of production factors." In the digital age, this condition requires a careful analysis of the technological impact on the transformation of the labor market. (Botnari, 2014).

I appreciate the approach of authors Andrei Cojuhari and Liuba Dorofeev, who argue that labor, considered a commodity, significantly influences the labor market through its "physiological, psychological, social, and moral" characteristics. Among the most significant characteristics are:

1) The labour potential of the population in the labour market is not negotiable.
2) The labour market is more organised and complex than other markets.
3) The digital labour market is based on contracts and active participation.
4) The labor market is also influenced by endogenous factors (Cojuhari & Dorofeev, 2014).

Over the past decade, economic literature has identified three main explanations for differences in income and growth between countries. The most solidly grounded explanation was based on the production function, according to the Solow model (1956). Recent studies on endogenous economic growth in the digital age have analyzed the impact of technology on the transformation of the labor market (Gwartney, Holcombe & Lawson, 2004).

2. Literature Review

The Solow model has formed the basis for several studies on economic growth. In addition, approaches that contradict it are compared from the perspective of this

model. Understanding the model is crucial for theories of economic growth in the digital age (Romer, 2012, p. 8).

Solow approached the model of endogenous economic growth through the accumulation of physical capital and its role in production. This model treated the accumulation of knowledge as an endogenous factor, which was generated from within the economy, but not demanded from outside. Therefore, the model has distinct perspectives on how investments in research and development (R&D) and education have not only driven technological progress but also led to the transformation of the labor market. Thus, economic growth in the digital age has been influenced. (Romer, 2012 p. 101).

In the early 1980s, economic growth underwent a significant revival, stimulated by the limitations of previous economic theories and new technological perspectives in the digital age. Endogenous economic growth theories sought to find ways to change the assumption of diminishing returns in order to ensure a constant cycle. In Solow's model of endogenous economic growth, the subject of exogenous technology became relevant in research. In his seminal 1956 paper, economist Solow set out to analyze whether an autonomous cycle of production, saving, and investment could lead to endogenous growth. However, Figure 1 shows that cyclical growth declines with each rotation as a result of diminishing returns to capital. Solow's economic growth cycle is schematically represented as follows:

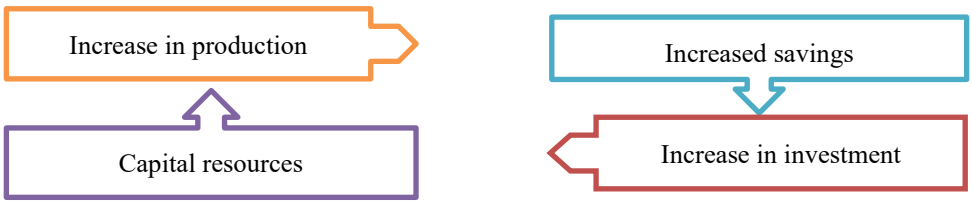

Figure 1. Economic growth cycle

Source: Romer, 2012, p. 4

In Figure 1, each stage of capital resource growth causes a smaller increase in production compared to the previous one, so the growth cycle gradually slows down. Therefore, only exogenous variables such as technology and labor have been the "engines" of economic growth in the digital age (Romer, 2012, p. 4).

Compared to economist Solow's model, the endogenous economic growth cycle in Figure 2 did not need to be diminished, while the variables were repeated. This is because Figure 2 elucidated the economic growth cycle specific to an endogenous growth model. Although fixed capital resources certainly have a labor force and a fixed stock of technology. However, it was not clear whether technological progress

was the performance of research and development (R&D). Thus, technological progress was subject to diminishing returns (Romer, 2012, p. 5).

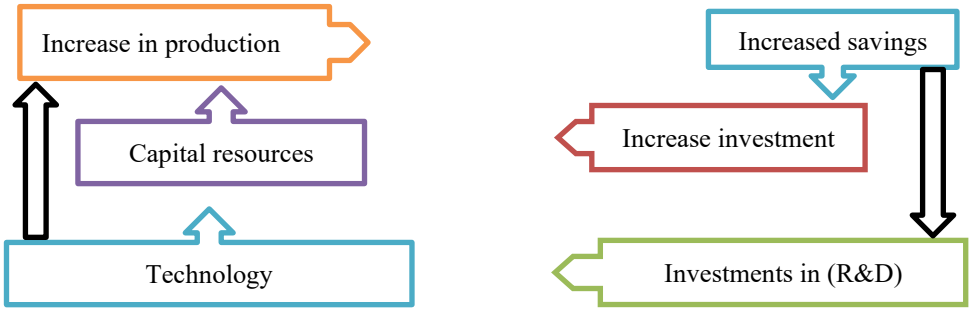

Figure 2. The endogenous economic growth cycle

Source: Romer, 2012, p. 5

The essential concept of endogenous economic growth reveals that investments in both physical capital resources and new technology determine the maintenance of the endogenous economic growth cycle without diminution in the digital age (Romer, 2012, p. 6).

An important issue is the question of what incentives human factors have to invest in technological education or research. Thus, human factors expected revenues generated from these activities to provide them with a value equivalent to the return on investment in physical capital (Parker, 2019, p. 6).

In economist Solow's model, capital-generated growth was limited due to diminishing returns in the process of its reproduction.

Therefore, in Solow's model, capital-driven growth was limited. Thus, as capital grew, its additional contribution to production declined, causing the economy to stagnate because capital could no longer grow relative to other factors of production. The same was true of new technology in the digital age: when physical capital is limited, the growth generated by technology is ultimately limited, and without growth in the labor factor, the economy reaches a state of stagnation (Parker, 2019, p. 15).

The Solow model had constant returns to scale for labor and capital, but decreasing returns only for the capital factor (Parker, 2019, p. 18).

Fundamental economic variables, such as the savings rate, influenced both real output and economic growth. Technological impact, in the economic growth model with returns to scale, contributed to the allocation of capital resources to research and development (R&D), which stimulated long-term changes in the growth rate. In the endogenous economic growth model, both economic variables and technological

impact had “growth effects” in the long term, not just on current output (Parker, 2019, p. 21).

This situation has significantly influenced modern endogenous economic growth theory, highlighting the importance of technological impact in the digital age. Technological impact did not occur passively but was the result of planned actions in the field of innovation. Investments in research and development (R&D) led to the development of technological potential and increased productivity in the digital age. These strategies strengthened sustainable economic development, generating a long-term positive impact on the economy. Thus, technological progress and competitiveness increased in various economic sectors in the labor market. Therefore, economic entities operating in perfect competition in the market did not achieve pure profits in equilibrium, but technology provided constant productivity and caused transformation in the labor market (Parker, 2019).

Dinu Marin and Cristian Socol emphasized that, according to the Solow model of economic growth, “technical progress and investment in new technology must be encouraged.” These elements are essential for sustainable economic development in the digital age, as innovation and modern technology have contributed significantly to increasing productivity and the standard of living of the population by transforming the labor market (Marin & Socol, 2006).

The endogenous economic growth model in the digital age integrated both human and physical capital, using a “Cobb-Douglas production function.” This model, inspired by Solow, treated “the savings rate and the allocation of resources for human capital accumulation as exogenous,” facilitating quantitative analysis. Thus, the technological impact on the transformation of the labor market was assessed by measuring the real accumulation of capital (Romer, 2012, p. 151).

The model was established in continuous time, and the result at time t is presented as follows:

$$Y(t) = K(t)\alpha[A(t)]1 - \alpha \qquad (1)$$

where:

Y – total production

K– the capital

A– work efficiency

t – total volume of productive services provided by employees with various skill levels (Romer, 2012 p.152).

Therefore, in the context of endogenous economic growth in the digital age, technological impact and rapid changes in the labor market have played an essential role in how human capital and labor efficiency have evolved, thus directly

influencing the dynamics of economic growth. Therefore, an exogenous part *s* of production is saved, and capital depreciates at an exogenous rate *δ*. Therefore:

$$K'(t) = sY(t) - \delta K(t) \quad (2)$$

Therefore, labor efficiency increases at an exogenous rate g, which is expressed as follows:

$$A'(t) = gA(t) \quad (3)$$

The model was based on assumptions regarding how human capital is determined. The accumulation of human capital depended both on the efficiency with which a certain amount of resources was transformed into human capital and on the volume of resources allocated to this process. With regard to the production of human capital from a set of given inputs, the model considered that the level of human capital of each employee was determined exclusively by the "years of education" completed. The next part of the analysis explored the implications of including physical and human capital, already existing among employees, as factors of production for human capital. Regarding the allocation of resources for the accumulation of human capital, the model, similar to the approach to physical capital, considered this allocation to be exogenous. Thus, to simplify the analysis, it was assumed that all employees achieve the "same level of education", and in most cases this level remains constant over time.

In the context of endogenous economic growth in the digital age, technological impact and labor market transformations have significantly influenced how human capital is accumulated and utilized. Thus, the importance of adapting education and lifelong learning to meet the needs of the economy in the digital age has been highlighted (Romer, 2012, p. 152).

3. Research Methods

The methodology of the research on endogenous economic growth in the digital age involved an analysis of theoretical and practical material on the impact of technology on the transformation of the labor market. This analysis was based on economist Solow's model, in which investments in research and development (R&D) and education stimulated technological progress in the digital age. The observation method was used to highlight the process of economic growth generated by physical and human capital, which is limited in the digital age. A questionnaire was also developed using Google Forms to identify the current situation of the population in terms of the technological impact specific to the digital age.

4. Results and Discussions

An analysis of the population aged 15+ by labor force participation for the first quarter of 2020-2024, according to the National Bureau of Statistics (NBS) of the Republic of Moldova, is presented in Figure 3.

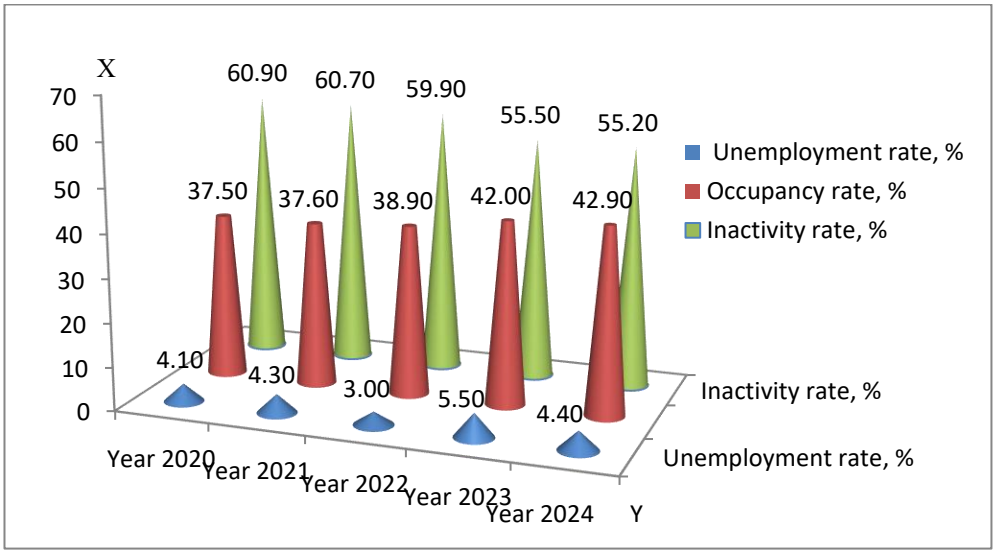

Figure 3. Population aged 15 and over, for the first quarter, 2020-2024

Source: Prepared by the author, based on statistical data from the "National Bureau of Statistics of the Republic of Moldova"

In the Republic of Moldova, the inactivity rate reached its highest level in 2020, at 60.90%, compared to 55.20% in 2024. These results were influenced by technological impact, which, following investments in human capital, remedied the situation. The employment rate in 2020 was 37.50%, slightly up from 42.90% in 2024. This was due to the training of the population, in line with the adaptation of education and lifelong learning. Thus, the unemployment rate in 2020 compared to 2023 was lower, from 4.10% in 2020 to 5.50% in 2023, but from 2024, the unemployment rate began to decline. This increase in unemployment was influenced by the technological impact on technological progress in various economic sectors in the Moldovan labor market. Therefore, there was an increased need for investment in human capital in order to grow the economy. In the digital age, both human and physical capital have been integrated, resulting in a gradual increase in the employment rate in 2024 compared to 2020 by 5.40% and a reduction in the inactivity rate by 5.70% from 2020 to 2024 (National Bureau of Statistics of the Republic of Moldova, 2024).

A questionnaire was developed in Google Forms, to which 259 respondents answered in June 2025. The purpose of this questionnaire was to analyze the population's perception of the technological impact of the digital age. Respondents answered 20 questions. To the question: Which of the following do you consider to be key endogenous factors for economic growth? 74.4% of respondents checked the answer "investment in research and development" and 69.2% checked "human capital." To the question: How do you assess the technological impact on jobs in your field? 53.8% of respondents checked the answer "positive" and only 23.1% of respondents checked the answer "neutral," which shows that people are adapting to the needs of economic growth in the digital age. Question: What percentage of your current work activities have been digitized in the last 5 years? Therefore, 43.6% of respondents checked the answer option 10-30% and 35.9% of respondents checked the answer 30-50%. And 10.3% of respondents checked the answer options below 10%, and also over 50% of current work activities have been digitized in the last 5 years, since the COVID-19 pandemic. Question: What is the biggest benefit of digitization in your sector? 46.2% of respondents checked the answer "increased productivity," 25.6% checked "flexibility," 17.9% checked "opportunities for innovation," and only 10.3% checked "cost reduction." These answers show that the job market is going through a transformation in the digital age. When asked, "What significant risks does digitalization bring?" digital transformation? Respondents could select up to two answers. 79.5% of respondents selected "technological unemployment," 28.2% selected "social inequalities", 53.8% selected "digital divide", and 23.1% selected "surveillance" as the significant risk posed by digital transformation. To the question: How has the demand for digital skills in your field evolved over the last decade? 35.9% of respondents checked the answer options "rapidly increasing" and "moderately increasing," and 23.1% of respondents indicated a "stable" demand for digital skills. Therefore, the demand for skills digital skills is significant in the digital age in order to grow the economy. When asked: Which soft skills are most valuable in the current context? Respondents were able to choose a maximum of two answers. 66.7% of respondents checked "adaptability" as the most valuable non-technical skill in the digital age. 64.1% of respondents checked "critical thinking." 35.9% of respondents checked "creativity" and 28.9% of respondents checked "collaboration" as important skills. These answers indicate that, in the digital age, the labor market requires adaptable and creative human capital in the workplace in order to grow the economy. To the question: What types of professional training have you undergone in the last 3 years to adapt? 59% of respondents checked "digital courses," 38.5% of respondents checked "management development," 23.1% of respondents checked "no training," and 17.9% checked "reskilling." To the question: What government measures do you consider crucial for supporting endogenous growth? Respondents had the opportunity to select up to two answers. Thus, 82.1% of respondents checked the answer "investment in education," while

46.2% of respondents checked the answer that would support endogenous growth, "digital infrastructure." Only 30.8% of respondents checked "research incentives" and 20.5% of respondents checked "legislative reforms" as the government measure to support endogenous growth. Thus, respondents mentioned the importance of government involvement in the digital age. To the question: How prepared do you feel for future technological changes? 48.7% of respondents checked the "well" answer option, 35.9% checked the "moderately" answer option, feeling prepared for future technological changes in the digital age. 17.9% of respondents selected "very well", 2.6% checked "a little," and most importantly, no respondent checked "not at all". This means that the population has minimal digital skills for future technological changes. To the question: What role does Entrepreneurship in job creation in the digital economy? For 46.2% of respondents, entrepreneurship plays an "essential" and "key" role, while for 7.7% of respondents, the role of entrepreneurship is "minor" in the digital economy. The "negligible" answer option was not selected by respondents, which means that entrepreneurship was a key pillar of digital economic growth. Question: How do you assess the impact of AI technology on your sector over the next 10 years? 43.6% assessed the impact of technology by selecting the "positive" answer option, 25.6% of respondents assessed it by selecting the "neutral" answer, 20.5% of respondents assessed the impact of AI in their sector as "very positive", but 7.7% of respondents assessed the impact of the technology in their sector as "negative". Importantly, respondents did not assess the impact of AI by selecting the answer options "very negative" and "because of this the need for personnel will decrease drastically", which means that respondents are optimistic about the use of AI. When asked: What percentage of the workforce in your field will require massive reskilling by 2030? 41% of respondents checked the answer option 40-60% of the workforce will require reskilling by 2030. 35.9% of respondents considered that only 20-40% of the workforce requires reskilling, and 12.8% of respondents selected the answer option that less than 20% of the workforce in their field requires reskilling. Essentially, 10.3% selected the answer that over 60% of the workforce will need reskilling by 2030. To the question: What is the main barrier to adopting advanced technologies in your organization? 35.9% of respondents who answered the questionnaire checked the answer "lack of qualified personnel". 33.3% of respondents checked the answer "cost" as a barrier to adapting to technologies, and 17.9% of respondents specified the barrier "resistance to change". It is essential to note that the answers "infrastructure" and "lack of, or difficulty in, initiative, determination to evolve and continuously develop an entity within its framework, but also to find suitable advanced technologies, in other words, a possible overly optimistic assessment of the capabilities and performance of an entity over an average period of time" were not selected by respondents, which means that there were no barriers to the adaptation of advanced technologies. The age of the respondents surveyed was

18-30 years old for 69.2%, 17 years old for 15.4% of respondents, and 46-60 years old for 12.8% of respondents surveyed. The field of activity of the respondents surveyed was 35.9% in "education," 25.6% in "other" fields than those mentioned in the questionnaire, and 20.5% in "services", as shown in Figure 4a.

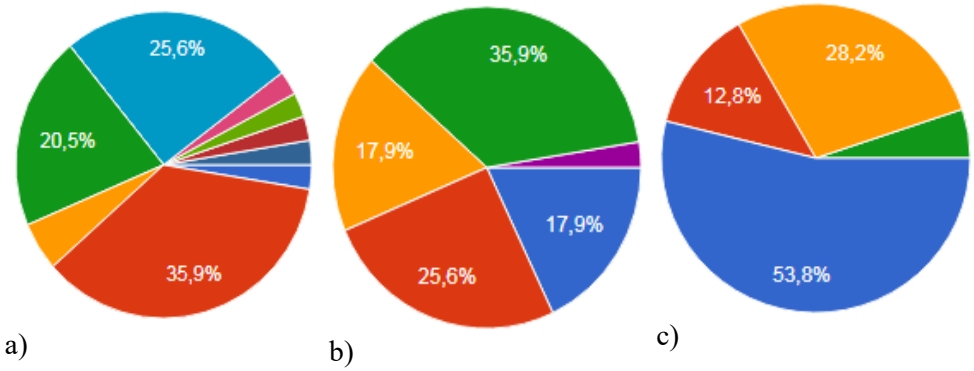

Figure 4. Technological impact on the labor market and factors influencing endogenous economic growth

Source: prepared by the author

Question from the questionnaire: What priorities do you recommend for educational policies in the context of technological changes? 35.9% of respondents checked the answer option "continuous training", 25.6% of respondents checked the answer option "development of soft skills". Thus, 17.9% of respondents ticked the need for "public-private partnerships" and "focus on Science, Technology, Engineering, Mathematics (STEM)", as shown in Figure 4b. Question in the questionnaire: How should the government respond to the growing inequalities caused by automation? 53.8% of respondents ticked the answer option "retraining programs" and "employment incentives." 12.8% of respondents felt the need for "social protection" from the government due to automation in order to boost the economy, as shown in Figure 4c.

5. Recommendations and Proposals for Economic Growth

1) Organizing continuous training within economic entities, in accordance with the needs of the occupation within the economic entity.

2) Flexibility in the automation of occupations within the economic entity in accordance with the skills possessed.

3) Supervision of employees should be monitored so that critical thinking allows them to perform their tasks successfully in order to grow the economy in the digital age.

4) The costs of continuous training in the field should be borne by the economic entity, not the employee.

5) Economic entities should organize psychological counseling and anti-stress activities for employees to facilitate the adaptation to the use of AI technologies.

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