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ECONOMIC EFFECT OF ARTIFICIAL INTELLIGENCE ON THE LABOR FORCE: COMPARISON BETWEEN DEVELOPED AND EMERGING COUNTRIES.

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Summary

This study analyzes the economic effect of artificial intelligence (AI) on the labor force, comparing its impact in two developed countries (United States and Germany) and two emerging countries (Brazil and Argentina), during the period 2012-2020. A non-experimental, cross-sectional, multivariate design is employed, using quantitative (panel data econometric model) and qualitative (content analysis by categories) techniques. The results show that in developed countries, an increase in R&D investment is associated with a decrease in unemployment, while in emerging economies it may increase it. These differences reflect the structural capabilities of each region to absorb and integrate advanced technologies. Implications for public policies focused on job training and technology investment are discussed.

Keywords: artificial intelligence, labor force, unemployment, R&D investment, developed countries, emerging countries.

Abstract

This study examines the economic impact of artificial intelligence (AI) on the labor force by comparing its effect in two developed countries (United States and Germany) and two emerging

economies (Brazil and Argentina) from 2012 to 2020. A non-experimental, cross-sectional, and multivariable design is applied, using both quantitative (panel data econometric model) and qualitative (categorical content analysis) techniques. Findings show that increased R&D investment in developed countries correlates with lower unemployment, while in emerging economies it may raise unemployment levels. These contrasting effects highlight the structural capabilities of each region to absorb and integrate advanced technologies. Policy implications regarding workforce upskilling and technological investment are discussed.

Keywords: artificial intelligence, labor force, unemployment, R&D investment, developed countries, emerging economies.

Sustainable Development Goal(s) (SDG) to which the research work is directed

8- DECENT WORK AND ECONOMIC GROWTH

Description

Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

Relationship with the research objetives

It revolutionizes labor markets by automating repetitive tasks and generating new career opportunities. It optimizes resource allocation and promotes economic growth.

Direct objective

9- INDUSTRY, INNOVATION AND INFRASTRUCTURE

Description

Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Relationship with the research objetives

It drives the digital transformation of industries, encouraging the adoption of advanced technologies and improving the efficiency of production processes. It contributes to achieving more sustainable and inclusive industrialization.

Indirect objetive

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Introduction

In recent years, artificial intelligence (AI) has ceased to be a tool limited to the technological sphere and has become a cross-cutting component in global economic development. While its implementation can increase productivity, it also poses considerable challenges for employment stability. The central concern relates to the capacity of economies to absorb technological change without generating structural unemployment or increasing social inequality.

Research has shown that the impact of AI varies according to the level of economic development. In countries such as the United States and Germany, strong technological infrastructure and sustained investment in research allow automation to be channeled into emerging sectors. However, in countries such as Brazil and Argentina, where investment levels are lower and digital divides are more pronounced, the same phenomenon can have adverse consequences.

This research seeks to compare the economic effect of AI on the workforce in developed and emerging countries, based on the analysis of economic, social and technological data between 2012 and 2020.

Theoretical Framework

Artificial intelligence refers to the set of technologies that enable machines to perform tasks that traditionally require human intelligence (Russell & Norvig, 2021). The adoption of these technologies has been most intense in sectors such as finance, health, manufacturing and defense (OECD, 2023). Several studies (Acemoglu & Restrepo, 2020; Georgieff & Hyee, 2022) warn about their possible displacing effect on the labor market.

On the other hand, the labor force is a macroeconomic indicator that reflects the active participation of the population in productive activities. Variables such as unemployment, labor productivity and educational level are key to understanding how an economy adjusts to automation processes.

In developed countries, the relationship between R&D and employment has been positive (Collen, 2021), while in emerging countries the effects are mixed, due to the lack of systematic investment and specialized human capital (Gasparini et al., 2020).

Artificial intelligence (AI) is a branch of computer science that seeks to create systems capable of performing tasks that normally require human intelligence, such as learning, problem solving or decision making (Russell & Norvig, 2021). In the labor context, AI has made it possible to automate repetitive processes, optimize production and transform the structure of various industries. This technological advance has generated a substantial impact on employment, especially in the demand for digital and technical skills.

Several authors agree that the adoption of AI has dual effects on the economy. On the one hand, it stimulates business efficiency and productivity; on the other hand, it can generate worker displacement, especially in manual or routine tasks (Brynjolfsson & McAfee, 2014). This phenomenon, known as "technological unemployment", has been widely studied since the first industrial revolution, and today it is intensifying with artificial intelligence and machine learning.

According to Acemoglu and Restrepo (2020), the impact of AI depends on the ability of countries to reallocate workers to new sectors. In economies with high investment in education and technology, AI can be a tool for inclusive growth. However, in contexts with low labor skills, it can amplify inequality by increasing the gap between highly skilled workers and those without digital skills.

Investment in research and development (R&D) is a determining factor for the effective absorption of AI in productive systems. In developed countries, this type of investment allows the generation of new jobs linked to the knowledge economy, while in emerging countries, the lack of R&D funding limits technological adoption and aggravates structural unemployment (OECD, 2023). Therefore, public policy plays a crucial role in mitigating the adverse effects of technological change.

Human capital also directly influences how AI affects employment. A highly skilled workforce is more adaptable to change and capable of performing tasks complementary to AI, such as data analysis or technology management. In contrast, a low-skilled workforce faces greater barriers to integrate into an increasingly digitized market, generating exclusion and greater labor informality (Autor, 2015).

Finally, the literature highlights the importance of the institutional context and digital infrastructure. AI does not have a uniform impact; its effect varies according to labor legislation, internet access, social protection and lifelong learning strategies. Hence, a comparison between developed and emerging countries allows us to visualize the differences in the capacity to adapt to the challenges posed by artificial intelligence in the global labor market.

Methodology

Research Design

This is a non-experimental, cross-sectional, documentary and multivariate study. No independent variables were manipulated, and data were collected retrospectively.

Population and Sample

Four countries were selected: USA and Germany (developed), and Brazil and Argentina (emerging). We worked with official indicators from the World Bank, UNESCO, IMF and OECD.

Variables

- Dependent: Unemployment rate.
- Independent: R&D investment (%GDP), tertiary enrollment, labor participation, wage earners (%), foreign direct investment, public spending on education.

Techniques and Instruments

Documentary observation and content analysis were used. The main instrument was a data recording matrix. The quantitative analysis was developed using panel data models.

This study adopts a mixed quantitative and qualitative approach, with a non-experimental, transectional and multivariate design. The research does not directly manipulate variables, but analyzes existing relationships based on historical and documentary data. The objective is to observe the behavior of the labor force as a function of investment in artificial intelligence (AI) during the period 2012-2020 in developed (United States and Germany) and emerging (Brazil and Argentina) countries.

The methodology used is documentary in nature, based on secondary sources from international organizations such as the World Bank, OECD and UNESCO. Through systematic observation techniques, a registration matrix was constructed to organize the key indicators: investment in R&D, unemployment rate, educational level, labor participation, proportion of salaried workers, foreign direct investment and public spending on education. These indicators were selected for their relevance in measuring the economic effect of AI.

For data processing, an econometric panel data model was applied. This technique is useful for analyzing multiple units (countries) over several years, making it possible to capture both temporal variations and structural differences between countries. Several models were developed: a general initial model, a global model with all variables, and separate models for developed and emerging countries. A model with individual interactive effects per country was also estimated to improve the precision of the estimates.

The qualitative analysis complemented the statistical part through interpretation by categories, identifying patterns and trends in the documents reviewed. This triangulation of methods allows for a more robust understanding of the phenomenon studied. The research focused on how the structural conditions of each country affect the adaptability of the labor force in the face of the advance of artificial intelligence. Thus, the methodology seeks not only to establish correlations, but also to understand the mechanisms that explain these relationships.

Results

The initial econometric model showed that higher R&D investment is negatively correlated with the unemployment rate in developed countries. In the U.S., each 1% increase in R&D reduces unemployment by 1.26%; in Germany, by 0.5%.

In contrast, in Argentina and Brazil, a 1% increase in R&D investment was associated with increases of 10.38% and 20.48% in unemployment, respectively. This suggests that, without technological absorption infrastructure and adequate training, investment in innovation can have an exclusionary effect.

The results obtained through the econometric panel data model indicate marked differences between the effect of investment in artificial intelligence (AI) on the labor force in developed and emerging countries. In the initial model, it was observed that a 1% increase in R&D spending is associated with an average 0.86% decrease in the unemployment rate. This result suggests that investment in technology, when well accompanied by structural policies, tends to stimulate employment generation.

In the global model, which incorporates all the independent variables and controls, it was found that GDP per capita, the labor participation rate and the percentage of salaried workers have a statistically significant relationship with unemployment. However, variables such as tertiary enrollment or public spending on education did not show significant effects in all scenarios, suggesting possible mismatches between educational investment and effective employability in the short term.

When segmenting the results by type of economy, contrasting behaviors were detected. In developed countries (United States and Germany), an increase in R&D investment reduced

unemployment, with effects of -1.26% and -0.5% respectively. In contrast, in emerging economies (Argentina and Brazil), the same increase in investment generated an increase in unemployment: +10.38% for Argentina and +20.48% for Brazil. This indicates that, without labor absorption mechanisms and specialized training, AI can have an exclusionary effect in vulnerable contexts.

Finally, models with individual interactive effects revealed that variables such as enrollment in tertiary education may even be positively correlated with unemployment, due to the mismatch between acquired skills and digital market demand. It was also identified that higher foreign direct investment is associated with lower unemployment rates, reinforcing the importance of fostering a favorable environment for attracting capital and technological innovation.

Discussion

The findings support theories that link technological development with economic growth only under favorable structural conditions. AI, far from being neutral, amplifies pre-existing inequalities. In developed countries, it promotes structural change and employment generation in high-skill sectors. In emerging countries, without compensatory policies, it can eliminate jobs without creating equivalent ones.

In addition, public spending on education showed ambivalent effects. In some cases, increased spending was not sufficient to reduce unemployment, due to mismatches between the education system and the demands of the digital market.

The findings of this research allow us to affirm that artificial intelligence (AI) has a differentiated impact on the labor force depending on the level of economic development of the country. In contexts where there are high investments in research and development (R&D), robust educational systems and active labor retraining policies, as in the case of the United States and Germany, AI can be a lever for growth, allowing to reduce unemployment and increase productivity.

In contrast, in emerging countries such as Brazil and Argentina, the implementation of AI-based technologies without an adequate support ecosystem can result in a net reduction of formal jobs. The study shows that in these countries, an increase in R&D investment correlates with an increase in the unemployment rate, suggesting that technology, when not accompanied by technical training and inclusive public policies, can widen the social and labor gap.

These results reinforce the idea that AI does not have a homogeneous effect, but that its consequences are mediated by structural factors such as human capital, technological absorptive capacity and labor market structure. In this sense, emerging countries face a

double challenge: to foster innovation and, simultaneously, to prevent it from deepening existing inequalities.

In short, AI represents both an opportunity and a threat to the labor economy. Its impact will depend on each country's ability to anticipate technological change, invest in quality education, promote digital inclusion and redesign its labor policies. Only through a comprehensive and adaptive approach will it be possible to turn technological transformation into a path towards sustainable and equitable development.

Conclusions

1. The effect of AI on unemployment depends on the economic context.
2. R&D investment reduces unemployment in developed countries, but can increase it in emerging countries if it is not accompanied by inclusive policies.
3. Technical training and educational adaptation are key to mitigating adverse effects.
4. Emerging economies require structural reforms to capitalize on the benefits of AI.

The effect of AI on unemployment depends on the economic context.

This research shows that the impact of artificial intelligence on the labor force is neither uniform nor universal. Instead of producing a homogeneous effect, AI interacts with the structural conditions of each economy: level of development, institutional framework, quality of employment and technological capabilities. In countries with diversified production systems, access to digital infrastructure and active employment policies, AI tends to generate job opportunities. On the other hand, in environments where informal jobs and low skills predominate, automation can result in labor displacement without effective reintegration mechanisms.

R&D investment reduces unemployment in developed countries, but can increase it in emerging countries if it is not accompanied by inclusive policies.

The results of the econometric model show that increased R&D spending in countries such as the United States and Germany is associated with a significant decrease in the unemployment rate. This suggests that these countries are prepared to transform innovation into new forms of employment. However, in countries such as Brazil and Argentina, the same type of investment showed a positive correlation with unemployment. This could be explained by the lack of conditions for translating innovation into social benefits, highlighting the need to accompany technological progress with strategies for labor inclusion and social protection.

Technical training and educational adaptation are key to mitigating adverse effects.

One of the central findings of the study is that tertiary education alone does not guarantee a reduction in unemployment if it is not aligned with the demands of the digital market. A profound transformation of education systems is required to enable the development of digital skills, critical thinking and adaptability. Technical, continuous and specialized training is essential for workers to be able to integrate into an increasingly automated work environment. In addition, public policies should promote the retraining of workers displaced by AI to complementary sectors, where non-automatable human skills are required.

Emerging economies require structural reforms to capitalize on the benefits of AI.

Empirical evidence suggests that without profound changes in the development model, emerging economies risk being left behind in the face of the fourth industrial revolution. The necessary reforms include not only greater investment in science and technology, but also regulatory frameworks that favor the adoption of AI with social justice. This involves strengthening education systems, improving digital infrastructure, ensuring equitable access to technology and designing fiscal policies that incentivize innovation. Only through this comprehensive approach will it be possible to transform the potential of AI into a driver of inclusive and sustainable development.

Limitations and Recommendations

Limitations

- The study is limited to 4 countries and the period 2012-2020.
- Lack of disaggregated data on types of employment and specific sectors.

Recommendations

- Extend the analysis to more countries and post-pandemic years.
- Include sectoral case studies.
- Develop more specific indicators of AI adoption.

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Strengthening technical and digital education

Emerging countries need to prioritize educational reform aimed at developing digital skills, computational thinking and artificial intelligence literacy. Curricula should be updated to include

skills adapted to the new economy, and continuing education programs for workers at risk of technological displacement should be integrated.

Implement inclusive and proactive public policies

Governments must design strategies that accompany the digital transformation with social protection and labor reconversion measures. This implies generating tax incentives for companies that promote training, as well as establishing labor transition programs for the most vulnerable sectors. Policies must anticipate change, not just react to its effects.

Promote innovation ecosystems adapted to the local context

It is essential to promote innovation models that respond to the specific needs of each country. This requires articulating efforts between universities, the private sector and the State to create sustainable technology clusters that stimulate the responsible adoption of AI in priority productive sectors. In addition, local research and development capabilities must be strengthened through public funding and international partnerships.

Deepen the measurement of the real impact of AI on employment

It is recommended that progress be made in the creation of specific indicators that allow a more precise measurement of the degree of penetration of artificial intelligence in the economies, differentiating between sectors, type of employment and level of qualification. This information is key for the design of evidence-based public policies and to avoid generic responses to complex phenomena.

Limitations of the study

This work has some limitations that should be considered when interpreting the results. First, the study is limited to the analysis of four countries, which, although useful for comparison between developed and emerging economies, does not allow for global generalizations. It would be necessary to broaden the sample to capture a greater diversity of economic, cultural and technological contexts.

Second, the availability of comparable data across countries and over time represents a major constraint. Some key variables, such as quality of employment, intensity of AI use by sector or specific training in technology, could not be included due to lack of reliable and homogeneous records.

Third, the variable “R&D investment” was used as a proxy for the technological effort in AI, which may underestimate or overestimate its true impact. AI is a cross-cutting technology,

integrated into multiple innovation processes that are not always recorded separately within overall research spending.

Finally, the approach used-although robust in its combination of qualitative and quantitative methods-does not allow us to establish definitive causal relationships. The observed correlations suggest significant links, but future studies should apply advanced methodologies, such as dynamic models or experimental designs, to validate the proposed mechanisms.

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