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Additional information and an imprint – p. 115

CONTENTS

From the Editorial Committee 5

Andrzej CHMIELA, Beata BARSZCZOWSKA, Małgorzata MAGDZIARCZYK, Adam SMOLIŃSKI: Social aspects of employment in the Polish hard coal mining industry 7

Yacine GUETTOUFI: Macroeconomic determinants of economic growth in Algeria: an ARDL bounds testing approach, 1980-2024 25

Justyna LIPIŃSKA: Perception of information and the quality of decision-making under conditions of cognitive warfare 41

Timilehin Olasoji OLUBIYI: Exploring the role of competition and diversification strategy in driving business sales growth in Africa's consumer goods industry 53

Djamel SADFI, Miloud FERHOUL: Analysis of the Impact of Entrepreneurial Initiatives on Sustainable Development in Algeria 71

Maksym SIKALO: Synergy of digital transformation and public governance for rapid growth of socio-economic systems in leading countries 101

Additional information 115

From the Editorial Committee

We are giving you the next Vol. 31, No. 3(2026) issue of the scientific journal of the Faculty of Management of the Rzeszów University of Technology entitled “Modern Management Review”.

The primary objective of the journal is to promote publishing of the results of scientific research within economic and social issues in economics, law, finance, management, marketing, logistics, as well as politics, corporate history and social sciences.

Our aim is also to raise the merits and the international position of the journal published by our Faculty. That is why we provided foreign Advisory Board, as well as an international team of Reviewers to increase the value of the scientific publications.

The works placed in this issue include many assumptions and decisions, theoretical solutions as well as research results, analyses, comparisons and reflections of the Authors.

We would like to thank all those who contributed to the issue of the journal and we hope that published articles will meet your kind interest and will be an inspiration for further research and discussions.

With compliments
Editorial Committee

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SOCIAL ASPECTS OF EMPLOYMENT IN THE POLISH HARD COAL MINING INDUSTRY

The purpose of this analysis is to present the current state of employment structures in Polish hard coal mines and to propose directions for future change. The study examines selected data reported by Polish hard coal producers in compliance with statutory reporting requirements. This information is collected via the "Polish Coal Market" ("Polski Rynek Węgla") platform, managed by the Katowice Branch of the Industrial Development Agency JSC. The primary contribution of this text is its presentation of the current landscape of the hard coal mining industry – based on the most recent available data – specifically regarding the management of employment levels. The analysis is conducted using data aggregated for the entire sector. Relying solely on "raw" data reported by mining enterprises can lead to erroneous conclusions; it is only by examining specific unit values for individual parameters that the true challenges facing the sector are revealed. Furthermore, the text suggests potential strategies for implementing structural changes to employment levels within the mining industry.

Keywords: hard coal mining, mining restructuring, decarbonisation of the economy, energy transformation.

1. INTRODUCTION

The decarbonisation of economies reduces demand for fossil fuels. The largest component of mining costs is expenditure related to wages, broadly defined (Barszczowska, 2024). Intervention in this area can most rapidly lead to improved efficiency of mining operations. In regions traditionally associated with hard coal mining,

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the social challenge is the need to reduce employment resulting from declining production. This issue will affect the management boards of mining companies, local governments, central administration, and, above all, potentially redundant workers and their families. This article analyses the key factors related to employment levels that influence the efficiency of hard coal mining in Polish mines. The current state of the sector and the observed trends in recent years provide the basis for forecasting potential directions of coal sector restructuring at both national and international levels (Biały et al., 2020; Gawęda et al., 2025). In line with these trends, Poland is restructuring its hard coal mining industry to adapt to new environmental challenges and market conditions (Chmiela, 2022; Smoliło et al., 2021). The mining restructuring processes and the shift away from fossil fuel energy production as part of the transition to a zero-emission economy have been compounded by global crises such as the COVID-19 pandemic and the war in Ukraine (Mozharovskyi et al., 2025; Redziuk, 2022; Shekhunova et al., 2023). The Polish energy sector has traditionally been linked to energy generation from fossil fuels, and its generation and transmission infrastructure is adapted to this method of energy generation (Chmiela et al., 2025; Gomółka, Kasprzak, 2023). Therefore, due to the need to ensure energy security, an immediate transition away from coal is impossible in Poland (Bluszcz, 2019; Manowska et al., 2024; Strzałkowski, Maruszczyk, 2024). To allow time and resources for the necessary structural changes in the energy sector, a transition period will be necessary, during which at least some of the energy will be generated from coal combustion. During this period, the Polish hard coal mining industry must provide a sufficient and economically viable volume of coal to stabilize the grid through coal-fired power plants, and local and central administration must prevent unfavorable changes in local communities (Abdulnbi Nayyef et al., 2024; Prakash Pandey et al., 2022; Wyrzykowska, 2022).

2. RESTRUCTURING OF HARD COAL MINING IN POLAND

In Poland, restructuring has been underway since the political and systemic changes of 1989 and the transition from a centrally planned economy to a market economy. The need for economic restructuring was strongly linked to the political and economic transformations of the state (Chmiela, 2022; Siciński, 2024; Wyrzykowska, Janiszek, 2025). State-owned enterprises, including mining companies, were expected to become independent, self-governing, and self-financing. Restructuring was primarily associated with rescuing large state-owned companies from bankruptcy, which could have resulted in the disappearance of the largest local employers and potential social unrest. Adjustment processes were most often carried out with state budget support (Barszczowska, 2024; Gasidło, Wyrzykowska, 2022; Skibski, Barszczowska, 2024). After 1989, the restructuring of the mining industry, adapting the sector to new technologies and market changes, resulted in the creation of 70 coal mines operating as state-owned enterprises, as well as 27 companies providing services to these mines. In the case of the Polish hard coal mining industry, restructuring is remedial and partially adaptive in nature. It also involves reorienting the goals and missions of enterprises so that they can adapt their resources to current and anticipated future changes in the environment (Strzałkowski, Strzałkowska, 2023; Wyrzykowska, 2025a). Restructuring, which adapts the sector to changes in the environment, aims to improve the efficiency of mining units and optimally utilize their resources (Bąk et al., 2024; Bluszcz, 2019; Sobczyk, Kopacz, 2018). Over the years, many more or less successful attempts have been made to improve the sector's situation. The

long-term restructuring process has led to significant changes in the structure of the hard coal mining sector. In Poland, in 2024, mining was conducted by eight mining companies using 18 operating mining units (Chećko et al., 2022; Prusek, Turek, 2018). The number of mining units cannot be understood as the number of active mines. Some of the currently operating mining units are single-unit structures, but some are multi-unit structures consisting of two or more mines (Act, 2024; Sobczyk et al., 2020).

In May 2021, the management boards of mining companies and representatives of trade unions and mining municipalities signed a so-called social agreement with the government regarding the transformation of the hard coal mining sector (Agreement, 2021). The agreement adopted a schedule for phasing out the mining capacity of coal production units by 2049. It was also established that a sustainable and gradual reduction in extraction, while simultaneously mitigating the socio-economic effects of the sector's transformation, would require a comprehensive system of financial support from public funds. The support system primarily includes subsidies for capacity reduction, as well as financing from the state budget of costs resulting from the termination of hard coal mining and mine closures (Bluszcz et al., 2015; Magdziarczyk et al., 2023; Wyrzykowska, Janiszek, 2025). In the new situation, the task of coal companies, taking into account the support system, is to safely and efficiently conduct mining until the individual limit of the existence of mining units established in the so-called Social Agreement (Agreement, 2021).

Since February 24, 2022, the provisions of the social contract have been affected by Russia's attack on Ukraine and the resulting statutory embargo on Russian coal. The new geopolitical situation and new market realities have forced temporary changes, including the redefinition of efficiency indicators and the updating of operational programmes of coal production units (Mozharovskyi et al., 2025; Redziuk, 2022; Shekhunova et al., 2023).

3. RESEARCH METHODS

As part of the commission to maintain public statistics and for the purpose of assessing the efficiency of hard coal resource exploitation in Poland, the Katowice Branch of the Industrial Development Agency JSC conducts research on the results of mining operations of its subordinate mining companies (IDA, 2025). On a micro and meso scale the restructuring processes in the hard coal mining sector are monitored. Based on data provided by mining companies, the Industrial Development Agency (IDA JSC) informs the relevant minister about the financial condition of mining companies, any irregularities in their operations, and the correctness of spending budget subsidies for structural reforms (Barszczowska, 2024; Skibski, Barszczowska, 2024).

The purpose of this analysis is to present the current situation and propose directions for changes in the employment structure within hard coal mines in Poland. As part of this research, the results of monitoring the restructuring process in the hard coal mining sector, conducted from 2014 to 2024 by the IDA JSC, were analysed. The research was based on data on hard coal mining processes in Poland, reported by mining companies as part of a statistical research program. The data was obtained from the website www.polskirynekwegla.pl (IDA, 2025) conducted by the Katowice Branch of the IDA JSC. Examining the “raw” data reported by mining companies can lead to incorrect conclusions; only by looking at the unit values of individual parameters do the true challenges facing the sector become apparent. The research attempted to identify the most important factors influencing mining efficiency. The impact of selected mining factors on the efficiency of the mining process was also analyzed. Ongoing adjustment processes must

be based on an up-to-date analysis of the sector's conditions and market situation. The presented analysis of selected aspects of mining is one of the tools enabling the development of an effective adjustment policy, therefore the dataset obtained during the research will enable work on determining potential directions of change in the coal sector in the near future.

4. RESULTS AND DISCUSSION

All mining companies (7/8), with the exception for one small private enterprise, provide IDA JSC with the data required for the research. Consequently, the presented statistics do not include this company and are based on data supplied by other mining companies. Owning to the limited scope of this company's operations, its results may be statistically insignificant, and the resulting aggregated picture of the sector differs only marginally from the actual figures (IDA, 2025).

The transformation of the hard coal mining sector is driving a decline in production. At the end of 2024, approximately 44 million Mg of coal was mined (9% less year-on-year), of which 32.6 million Mg was thermal coal (a decrease of approximately 10% year-on-year), and 11.4 million Mg was coking coal (only 4% less year-on-year). Thermal coal mining in Poland has been steadily declining for years, while coking coal mining remains roughly stable. It should be assumed that mining of coking coal, classified as a critical raw material, will continue at a similar level. Analysis of reporting data indicated that some parameters of hard coal mining in Poland sometimes showed rapid changes, not always resulting from the phase-out process (Barszczowska, 2024).

Mining in accordance with good mining practice results in a continuous increase in the mining depth. Increasing mining depth, not only in Polish hard coal mining, increases mining hazards. Mining in increasingly difficult mining and geological conditions translates into higher production costs (Figure 1). From 2014 to 2017, a more or less constant increase in production costs was observed, at approximately PLN 6.3/Mg/year, or approximately 2% year-on-year. This increase may be attributed to the systematic increase in mining difficulty. The lowest mining costs during this period were recorded in 2016, at PLN 254/Mg. From 2022, costs have increased rapidly, reaching PLN 713/Mg in 2024. Over these three years, mining costs have increased by approximately 100%.

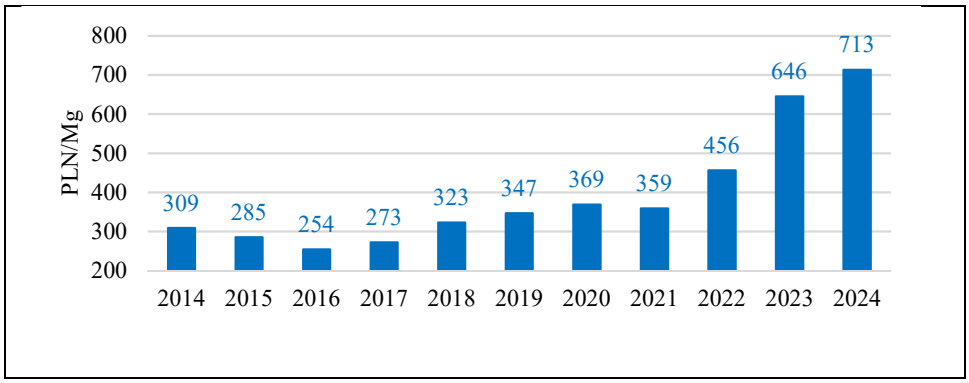


Figure 1. Average unit cost of coal extraction [PLN/Mg]

Source: Own study based on (IDA, 2025).

The structure of the unit cost of hard coal production in 2024 is presented in Figure 2. Irrespective of the year, the largest component of the unit cost of hard coal production is wages, contributions, and employee benefits. In 2024, this component accounted for approximately 46.4% of total mining costs, consisting of wages (34.17%), mandatory wage contributions (7.67%), and employee benefits (4.55%).

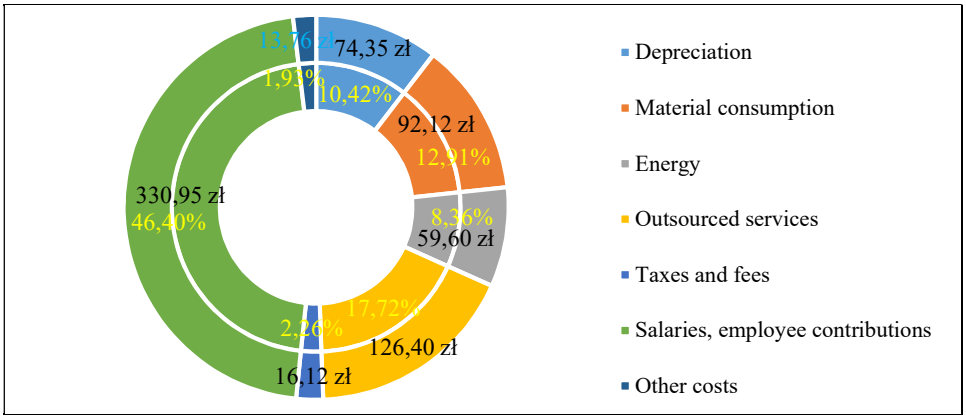


Figure 2. Unit cost of coal production in 2024

Source: Own study based on (IDA, 2025).

The cost of production directly results from the level of employment, and since wages are the largest cost component, reducing this component would most easily improve the sector's efficiency (Gawęda, 2024; Magdziarczyk et al., 2024). From a social perspective, it is difficult to imagine reducing miners' wages. The only socially acceptable way to reduce the wage fund is to limit employment, which does not involve collective layoffs. The level of employment has been gradually declining since 2014 (Figure 3), and in 2024, a decrease of approximately 29% was recorded compared to 2014. Ultimately, at the end of 2024, the mining industry employed 75,000 people, including 58,200 underground and 16,800 on the surface (Figure 3).

During the analysed period from 2014 to 2024, the first four years from 2014 to 2017 witnessed a significant reduction in employment. The decline amounted to approximately 23,500 employees, representing a fall of around 22%. In 2014, the sector employed 106,100 workers, including 81,500 underground and 24,500 surface employees. Over the subsequent seven years, employment decreased at a much slower rate. The reduction was limited to 7,600 employees, corresponding to a decline of only 7% compared with 2014. By 2014, relative to the reference year of 2014, underground employment had fallen by approximately 29%, while surface employment had decreased by around 31%. This indicates a more pronounced decline among underground workers. To better illustrate the dynamics of sector restructuring, Figure 4 compares the changes in production volume and employment in hard coal mines. For both parameters compared parameters, 2014 was taken as the reference year, with values standardised to 100%Since then a downward trend in their values has been observed, but the declines have different dynamics. Hard coal production has allowed a relatively steady downward trajectory, decreasing by 39 percentage points. The exception was 2021, when global demand for fossil fuels temporarily boosted production. Employment, however, has followed a different pattern.

Between 2014 and 2017, employment declined by 22 percentage points, broadly corresponding to the reduction in production. Since 2017, employment levels have remained relatively stable. Over the following seven years, employment decreased by only 7 percentage points, equating to an average reduction of 1 percentage point per year.

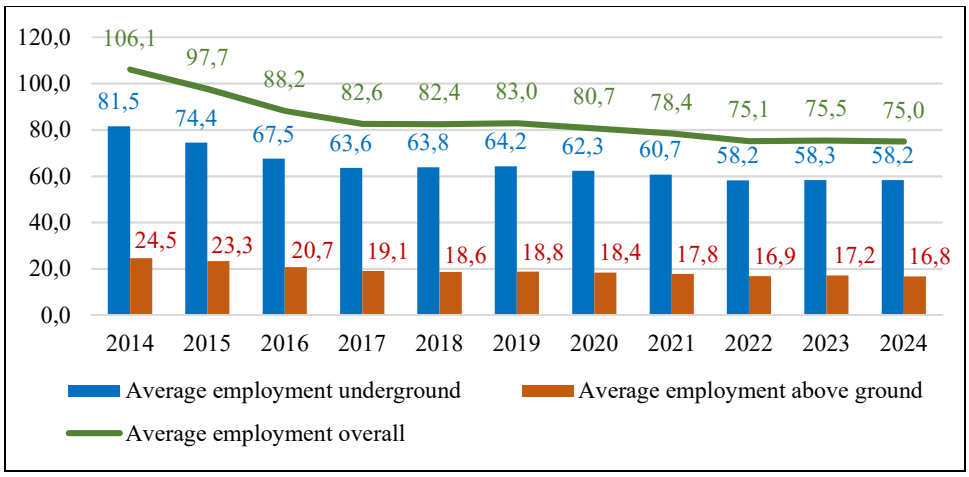


Figure 3. Average employment in hard coal mines [thousands of employees]

Source: Own study based on (IDA, 2025).

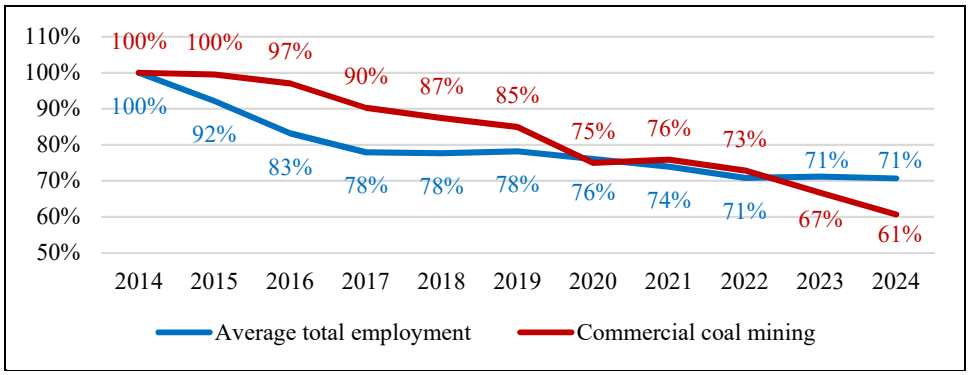


Figure 4. Comparison of the dynamics of changes in employment and production in hard coal mines.

Source: Own study based on (IDA, 2025).

Taking into account the declining demand for fossil fuels, particularly hard coal, employment in the mining industry should be further reduced for economic reasons (Bluszcz, Kijewska, 2016a; Gawęda, 2022; Wyrzykowska, 2025b). Government agreements, including ten-year employment guarantees at Jastrzębska Spółka Węglowa (JSW), which safeguard employees in the sector and were signed with trade unions, do not, however permit redundancies on economic grounds (Agreement, 2021). Reducing employment through the introduction of social packages (such as mining leaves, one-time

severance payments), however, requires changes in legal regulations, which were still being processed at the time of preparation of this article. A good solution to the problem for the industry, employees and the state budget would be the rapid launch of a system of voluntary redundancies from the mining industry supported by public aid (Abdulnbi Nayyef et al., 2024; Prakash Pandey et al., 2022).

To analyze the correct employment levels in the sector, labor productivity is calculated. In mining, labor productivity is closely linked to production volume and employment levels (Bluszcz, Kijewska, 2016b; Ranosz et al., 2020). Due to the employment structure and diverse nature of work, statistics in mining typically analyze overall productivity and the productivity of underground workers, also known as underground productivity. In 2024, productivity fell to approximately 0.83 million Mg/work/year for underground workers and 0.59 million Mg/worker/year for all mine employees (Figure 5).

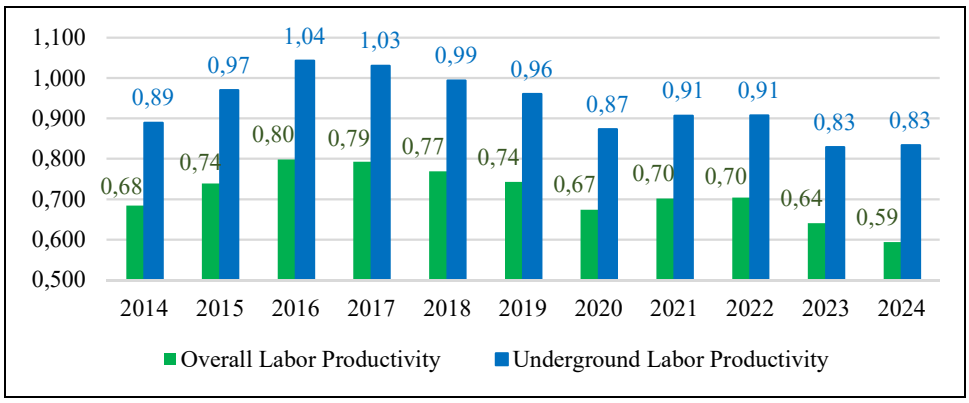


Figure 5. Labor productivity in hard coal mining [million Mg/worker]

Source: Own study based on (IDA, 2025).

Given the relatively stable employment structure in hard coal mines, patterns observed in one group of workers correspond to patterns in the other. Between 2014 and 2023, the difference between overall productivity and underground productivity was approximately 0.2 million Mg/worker; unfortunately, in 2024, this difference increased significantly to almost 0.25 million Mg/worker. During the same period, but excluding the final years of 2023 and 2024, productivity in hard coal mining exceeded 0.87 million Mg/worker for underground workers and 0.67 million Mg/worker for all mine employees. The peak year was 2016, when overall productivity surpassed 0.8 million Mg/worker and underground productivity exceeded 1 million Mg/worker (in both cases, 17% more than in 2014). The rapid increase in productivity up to 2016 may be attributed to reductions in employment, which corresponded with the decline in sectoral production. The subsequent slowdown and the decline observed in later years are consistent with the reduced pace of workforce departures from the mining industry, despite relatively unchanged levels of coal output.

A decline in overall productivity to 0.67 million Mg per worker and in underground productivity to 0.87 million Mg per worker was recorded in the pandemic year 2020 (Górska, 2023; Khomenko, Jelonek, 2023). This represented a year-on-year decrease of 9% in overall productivity and 11% in underground productivity. The reduction in

productivity was associated with pandemic-related preventive measures implemented during that year.

In 2023 and 2024, productivity fell further, by 7% for underground workers and by 6% and 16%, respectively, in 2023 and 2024 for all employees in the mining sector compared with the reference year 2014. This decline most likely resulted from the previously discussed decarbonisation of the economy and the protection of jobs in the mining industry guaranteed under the 2021 social agreement.

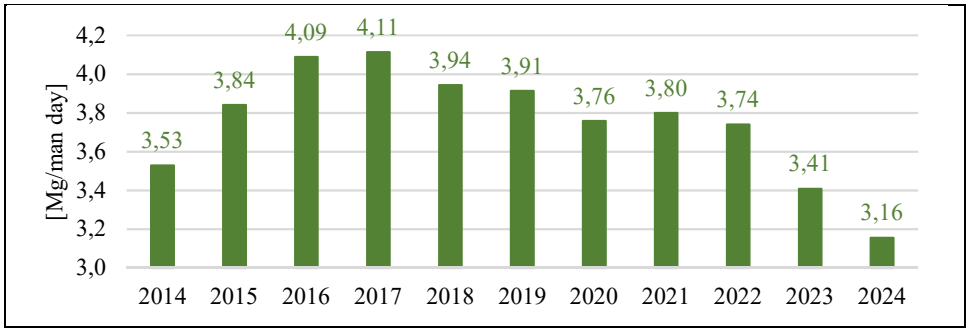


Figure 6. Labor productivity expressed in the amount of commercial coal production during one working day [Mg/man day]

Source: Own study based on (IDA, 2025).

Changes in productivity, measured by the number of days worked, exhibit a consistent pattern (Figure 6). Between 2014 and 2017, shift productivity demonstrated an upward trajectory, reaching 4.11 Mg per day in 2017, which represented a 16% increase relative to the reference year 2014. This improvement was primarily attributable to a reduction in employment occurring at a slightly faster pace than the decline in commercial coal production (Biały et al., 2020; Shavarskyi et al., 2022). In subsequent years, however, the slower rate of workforce reduction, combined with a constant rate of production decline, resulted in diminished shift productivity. During the period 2018-2022, the average mine worker extracted approximately 3.8 Mg per shift. In the following two years, stabilization in employment levels was accompanied by a marked decline in productivity, most likely associated with the introduction of subsidies aimed at reducing mining capacity. By 2024, the average output per worker is projected to fall to 3.16 Mg of commercial coal per shift, corresponding to only 77% of the 2017 level. This dimension of mining efficiency warrants particular attention from coal company management. The development of mechanisms, in collaboration with trade unions, to achieve a sustainable reduction in employment within the mining sector may contribute to mitigating this adverse trend. Wages, irrespective of the type of industrial activity, constitute one of the largest components of production costs (Bluszcz, Kijewska, 2016b; Chećko et al., 2024). In the mining sector, where working conditions are particularly demanding, it is expected that wage levels remain above the national average (Gajdzik et al., 2024; Hussein Salman, Abdulnbi Nayyef, 2024). Despite the unfavorable economic situation of enterprises operating within the support system, wages have shown a consistent upward trend (Figure 7). The only exception occurred in 2024, when a modest decline was observed in the hard coal mining industry, amounting to PLN 159, or 1.1% relative to the previous year.

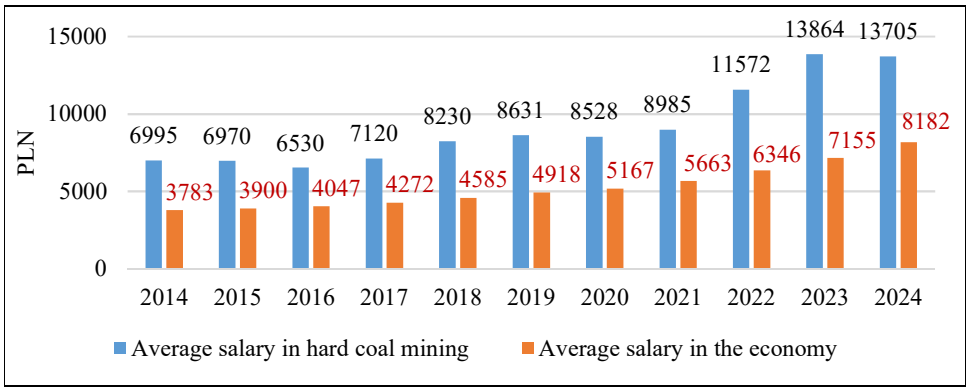


Figure 7. Average salary in the hard coal mining sector

Source: Own study based on (IDA, 2025).

Given the risk of potential social dissatisfaction, a substantial reduction in wages outside the mining sector is unlikely. According to data provided by the IDA JSC, the average monthly wage in the hard coal mining sector in 2024 amounted to PLN 13,720. For comparison, figures from the Central Statistical Office indicate that the average wage in the national economy during the same period was PLN 8,880. This comparison demonstrates that wages in hard coal mining exceeded the national average by approximately 55% (Górska, 2023), representing the highest salary level across the economy in 2024. It should be noted that the observed increase in wages is also attributable to the provisions of the Social Agreement of 2021 (Agreement, 2021) and its 2022 annex.

Figure 8 presents the distribution of wages in the hard coal mining industry in 2024, broken down by position, and the change in wages compared to 2023. Despite the small global reduction in wages in the hard coal mining sector, it can be noticed that the reduction applies to three groups of employees, but in one group, "administrative and office workers", a small increase of 2.11% in wages is recorded (IDA, 2025).

The highest-paid occupational group within the hard coal mining industry is represented by *engineering and technical workers*, whose remuneration exceeds the sectoral average by 24% (Korbiel, Czerwiński, 2022). The second largest group, *blue-collar workers*, receive wages amounting to 96% of the industry average. The lowest-paid categories correspond to the two smallest employee groups (Barszczowska, 2024; Du et al., 2024). Specifically, *administrative and office workers* earn approximately 89% of the average wage in hard coal mining, whereas *service and guard staff* receive 79% of the average. It should be noted that wage growth in the hard coal mining sector does not translate into improvements in labour productivity, which, as previously demonstrated, continues to exhibit a systematic decline (Figures 5 and 6) (Dragan, Zdyrko, 2023; Khomenko, Jelonek, 2023).

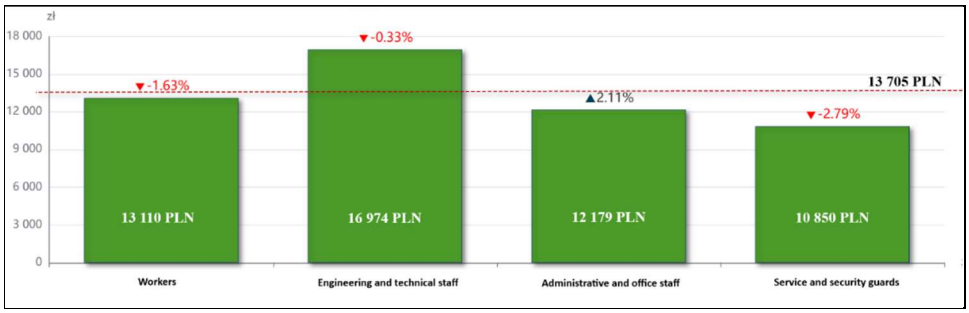


Figure 8. Average salaries by position in 2024 and comparison with data from 2023. Change in the average salary in the sector in 2024 by position

Source: Prepared by own on based on (IDA, 2025).

One way to evaluate the workforce is by assessing its ability to avoid the consequences of potentially hazardous situations. Furthermore, the included analysis of accident rates can help identify potential overstaffing. A factor influencing both the financial condition and public perception of the mining industry is the accident rate. Although mining is not the most hazardous industry, mining accidents – particularly large-scale incidents – tend to dominate media coverage. The number of mining accidents is presented in Figure 9.

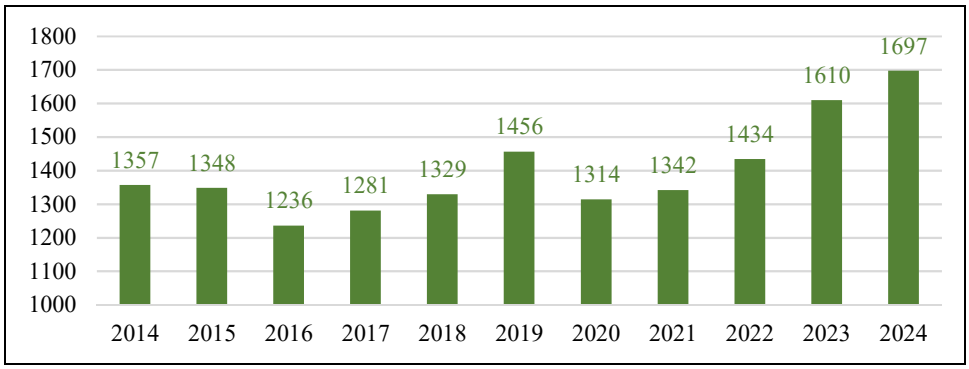


Figure 9. Number of accidents at work in hard coal mines (concerns the mine's own crew)

Source: Own study based on (IDA, 2025).

In the hard coal mining industry, two distinct periods can be identified in the number of accidents recorded since 2014. Between 2014 and 2022 (excluding 2019), a phase of relative stabilization was observed, with accident numbers remaining at approximately 1,350 per year. The lowest figure was recorded in 2016, when 1,236 accidents occurred, representing the lowest level documented in the Polish hard coal mining industry. In 2019, the number of accidents increased to 1,456. In 2020, a decline of 142 accidents was noted compared to 2019; however, this essentially reflected a return to the established level. It should be emphasized that in 2020, fewer working days due to sanitary restrictions and reduced production should have exerted a more pronounced effect on lowering accident frequency. In 2023 and 2024, the number of accidents is expected to be significantly higher than in the preceding period, and the upward trend unfortunately continues. Given the

steady decline in mining output and employment, combined with only a slight increase in mining hazards, the accident rate would be expected to decrease. Consequently, coal company management should investigate the underlying causes of this phenomenon and implement measures to improve the situation.

The absolute number of accidents may provide an incomplete picture of the accident rate in hard coal mining; therefore, Figure 10 presents the accident rate per 1,000 employees. Since 2014, the number of accidents per 1,000 employees has risen from 12.8 in 2014 to 17.1 in 2021. Over this seven-year period, the increase amounted to approximately 36%, or about 8% annually. As with the analysis of the absolute number of accidents, the exception was 2019, when the rate reached 17.6 accidents per 1,000 employees. In the subsequent three years, beginning in 2022, the accident rate continued to rise, reaching 22.6 accidents per 1,000 employees in 2024. This represents an overall increase of approximately 43% compared to 2014, equivalent to an average annual growth of 14%.

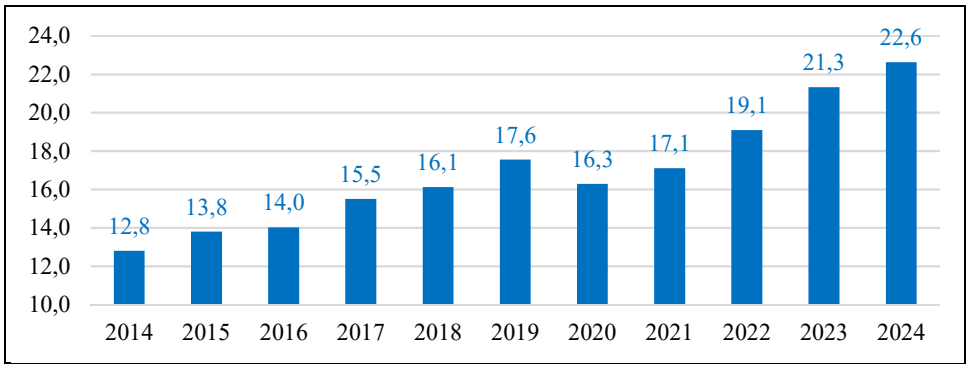


Figure 10. Number of accidents per 1000 employees (for the mine's own crew)

Source: Own study based on (IDA, 2025).

Another widely used indicator of accident frequency in mining is the number of accidents per 1 million Mg of production. Figure 11 presents changes in this measure in the Polish hard coal mining industry between 2014 and 2024. The analysis of accidents per 1 million Mg of commercial coal production reveals three distinct periods of variability.

The period from 2014 to 2017 was characterized by relative stabilization of the accident rate, at approximately 19 accidents per million Mg of coal produced. However, given the steady decline in production and employment, maintaining a constant accident rate should be regarded as an unfavorable phenomenon (Jevell et al., 2014). This situation deteriorated in the subsequent years, from 2018 to 2021, when a slight upward trend was observed, culminating in 24.4 accidents per million Mg of commercial coal extracted – an increase of 29% compared to 2014. The most adverse developments occurred in the last three years, from 2022 to 2024, when a pronounced upward trend was recorded. During this period, the accident rate rose to 38.6 accidents per million Mg of commercial coal produced, representing an increase of approximately 58% compared to 2021.

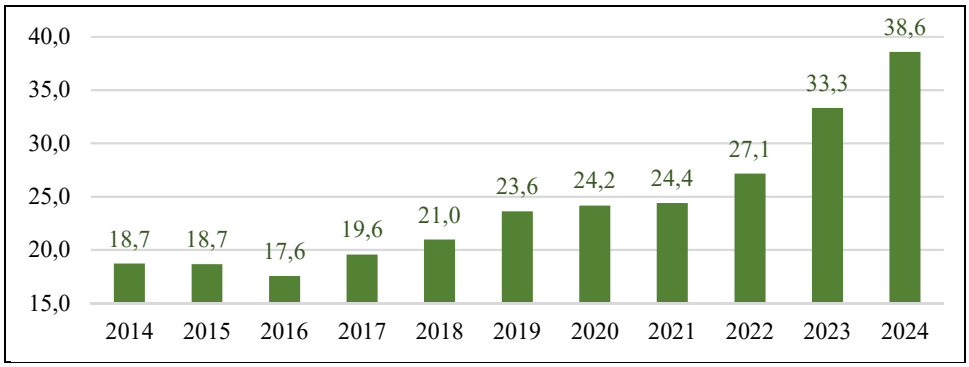


Figure 11. Number of accidents per 1 million Mg of production (concerning the mine's own crew)

Source: Own study based on (IDA, 2025).

Following the analysis of accident rate dynamics, it is recommended that the management boards of coal companies, together with their occupational safety services, urgently investigate the causes of this rapid increase, particularly in the last three years, and implement immediate measures to reverse this trend.

The last three years (2022-2024) have been a difficult period for the hard coal mining industry as a whole. Since 2022, unit mining costs have risen rapidly (Chmiela et al., 2023). Compared to 2021, the unit cost has nearly doubled. This increase may be partially attributable to inflation, although other factors must also have contributed. The largest component of mining costs is employment-related expenses, which account for approximately 46% of total costs. Intervention in this area could yield rapid and significant improvements in sectoral efficiency.

Concerns regarding mining efficiency are further reinforced by the slowdown in employment reductions since 2017. During this period, mining capacity has been consistently reduced, yet a roughly similar number of employees has been extracting progressively less coal each year. As a result, efficiency has declined markedly. Compared to 2022, overall sectoral efficiency fell by 8%, while employment decreased by only 0.01%. Such a sharp decline in productivity cannot be explained solely by deteriorating mining and geological conditions or by the need to employ a growing number of workers individually.

Despite being covered by the support system for mining capacity reduction, the period 2021-2024 witnessed a rapid increase in the wage bill, the largest component of mining costs. While this increase may be partially linked to inflation, the net financial results for 2024 nonetheless show a record loss of over PLN 6 billion. It should be emphasized that wage indexation was guaranteed by the provisions of the Social Agreement of May 2021 (Agreement, 2021) and its annex of March 2022.

A similarly adverse trend can be observed in accident rates, which, contrary to common belief, contribute to rising mining costs. With production volumes steadily declining, the absolute number of workplace accidents in hard coal mining increased by 18% over the past two years compared to 2022, reaching 1,697 accidents in 2024. Furthermore, 2023 and 2024 recorded sharp increases in the most frequently assessed accident indicators: the number of accidents per 1,000 employees and the number of accidents per unit of production. Compared to 2022, these indicators rose by 18% and 42%, respectively. The

record-high increase in the accident rate per production volume is particularly concerning. Coal company management boards should therefore prioritize immediate remedial measures to address this issue.

5. CONCLUSIONS

Over the past three years, the unit cost of mining has increased rapidly. Its largest component is the wage bill, which is largely dependent on employment levels. Addressing this component appears to be an effective way to restore the sector's efficiency. Reductions in the production capacity of the Polish hard coal mining industry should be accompanied by corresponding reductions in employment. Unfortunately, in recent years the decline in employment has been much smaller than would be expected given the reduction in production. Employment is even projected to increase in 2023. Compared to 2014, employment in 2024 decreased by 29%, while production volume fell by 39% over the same period. From an economic perspective, employment in the hard coal mining sector should be reduced more rapidly than is currently the case. However, the provisions of the Social Agreement do not allow for layoffs for economic reasons. Swift implementation of a voluntary redundancy system could help improve the industry's difficult economic situation.

During the past five years (since 2020), labour productivity calculated for all employees has remained almost unchanged, while productivity calculated specifically for underground workers has declined significantly, particularly in 2023 and 2024. A similarly large decline in productivity measured by the number of days worked is also evident. In both cases, the decline amounts to approximately 16% over these two years compared to 2022.

Both the number of occupational accidents and basic accident rates show a disturbing upward trend. The rapid increase in accident rates, measured in relation to production output, is particularly unfavourable. This increase cannot be explained solely by the exploitation of deposits located in increasingly difficult mining and geological conditions.

The selected elements presented here, describing the state of the hard coal mining industry in Poland, are partly the result of restructuring processes in the sector and the adaptation of the economy and energy industry to a zero-emissions model. However, some of the phenomena observed cannot be explained solely by ongoing restructuring or adverse mining and geological conditions. Company management should urgently focus on identifying the causes of these problems and implementing measures to prevent their escalation.

Due to the length of the text, a more detailed analysis of the correlation and regression of the available data has been deferred to subsequent installments, which will serve as a continuation of this piece.

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The authors declare that they have not used AI or AI-assisted tools during the preparation of this manuscript.

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MACROECONOMIC DETERMINANTS OF ECONOMIC GROWTH IN ALGERIA: AN ARDL BOUNDS TESTING APPROACH, 1980-2024

This study examines how investment, foreign direct investment (FDI), inflation, trade openness and government expenditure relate to economic growth in Algeria, a hydrocarbon-dependent economy. Annual World Bank data for 1980-2024 are analysed with the ARDL bounds-testing approach, using finite-sample critical values, parameter-stability tests and sub-sample and dummy-variable checks. Growth is stationary and the joint test on the lagged regressors does not support a long-run relationship. Trade openness has the only significant long-run coefficient (0.15, 5% level), but it is not robust once the 2020 contraction and other episodes are controlled for; capital formation, FDI, inflation and government expenditure are insignificant. The paper contributes a transparent, jointly estimated test that distinguishes statistical from economic significance and checks for the degenerate case of bounds testing. Policy implications are stated cautiously.

Keywords: economic growth, ARDL bounds testing, foreign direct investment, trade openness, Algeria.

1. INTRODUCTION

Economic growth is a central objective of economic policy, and its determinants have been studied since the neoclassical and endogenous growth models (Solow, 1956; Lucas, 1988; Barro, 1991). For resource-dependent economies the question is more demanding, because growth depends not only on capital accumulation, capital inflows and macroeconomic policy but also on the volatility of commodity revenues (Sachs, Warner, 1995; van der Ploeg, 2011). Algeria is a clear case. The World Bank (2025a) describes it as the largest African country and the third-largest Arab economy, which moved back to the upper-middle income group in July 2024 but whose main challenge remains its dependence on hydrocarbons: between 2019 and 2023 the sector accounted for 14% of GDP, 83% of exports and 47% of budget revenues.

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Growth has been recovering since the contraction of 5% in 2020 (Figure 1), with rates of 3.8%, 3.6% and 4.1% in 2021, 2022 and 2023, supported by public spending that rose by more than 60% between 2021 and 2023 (World Bank, 2025a). Whether this recovery rests on durable macroeconomic determinants or mainly on public spending and hydrocarbon revenues is an empirical question.

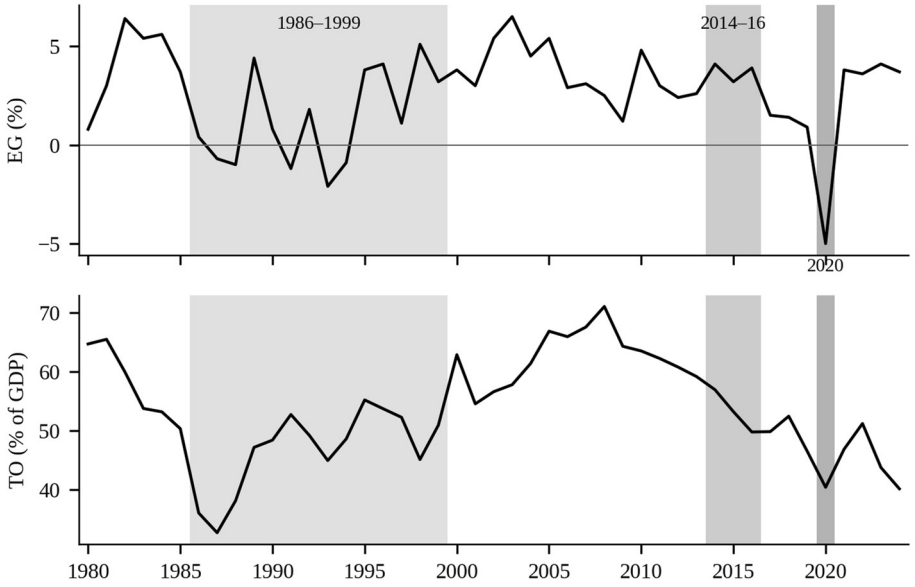


Figure 1. Economic growth (EG) and trade openness (TO), Algeria, 1980-2024

Source: Authors' elaboration based on World Bank (2026). Shaded areas: 1986-1999, 2014-2016 and 2020.

Research problem. Existing evidence for Algeria is fragmented. Studies typically examine one determinant at a time, such as FDI, public expenditure or inflation, over relatively short samples, and reach different conclusions (Cherakrak, Gaham, 2020; Smaili, Khelassi, 2021; Mahfoud, Atil, Benmazou, 2022; Kaddouri, Benelbar, 2024). It is therefore unclear which determinants have a robust long-run association with growth when considered jointly, how large their effects are in economic terms, and whether the published long-run relationships survive the checks that bounds testing requires when growth itself is stationary.

Research objective. The objective of this paper is to estimate the short-run and long-run relationships between real GDP growth and gross fixed capital formation, foreign direct investment, inflation, trade openness and government expenditure in Algeria over 1980--2024 within a single ARDL bounds-testing framework, and to assess both the statistical and the economic significance and the stability of the estimated effects.

Contribution. The paper contributes in three ways. First, it examines five growth determinants jointly over 45 years, a period that includes the oil-price collapse of the 1980s, the adjustment period of the 1990s, the hydrocarbon boom of the 2000s and the post-2020 recovery, rather than one determinant over a short window. Second, it complements the usual F-bounds test with the t-test on the lagged dependent variable and the F-test on the

lagged regressors, using finite-sample critical values, because the joint F-test can reject when the dependent variable is stationary even though no level relationship exists. Third, it reports the long-run and short-run coefficients and the error-correction term in full, converts coefficients into effects per standard deviation, and tests the stability of the estimates with recursive tests, a bootstrap sup-F test, break dummies and sub-samples. The paper does not claim to identify causal effects.

The paper is organised as follows. Section 2 reviews the literature and identifies areas of agreement and disagreement. Section 3 sets out the hypotheses, data and ARDL specification. Section 4 reports the results. Section 5 discusses the findings, their policy implications and limitations, and Section 6 concludes.

2. LITERATURE REVIEW

Growth theory supplies the expected signs. In the neoclassical model, capital accumulation raises output per worker along the transition path (Solow, 1956; Mankiw, Romer, Weil, 1992), and endogenous growth models give investment, knowledge spillovers and public inputs a lasting role (Lucas, 1988; Barro, 1990). Cross-country studies broadly agree that investment is positively associated with growth (Barro, 1991; De Long, Summers, 1991). There is less agreement on whether the relationship holds where a large share of investment is publicly financed and concentrated in one sector, since the quantity of investment may then be a poor indicator of its productivity.

On FDI, the literature agrees on the channels, namely technology transfer, managerial know-how and competition (Borensztein, De Gregorio, Lee, 1998; Blomström, Kokko, 1998), but not on the size or even the sign of the effect. Positive effects are conditional on the absorptive capacity of the host country, notably its human capital and the depth of local financial markets (Borensztein, De Gregorio, Lee, 1998; Alfaro et al., 2004), and the FDI–growth relationship may be endogenous (Li, Liu, 2005). This conditionality matters in Algeria, where FDI is small relative to GDP (Table 2) and, according to much of the national literature, concentrated in the energy sector.

Inflation is negatively associated with growth in many cross-country studies (Fischer, 1993), but the evidence is contested. Bruno, Easterly (1998) find that the negative correlation is driven mainly by episodes of very high inflation, and Khan, Senhadji (2001) estimate the threshold above which inflation significantly slows growth at 11-12% for developing countries and 1–3% for industrial countries. Algerian studies using threshold models report much lower values: 3.65% for 1970-2017 (Belgadi, 2020) and 5.91% for 1980-2020 (Mahfoud, Atil, Benmazou, 2022). If the effect is non-linear, a linear coefficient is an average over regimes.

Government expenditure is the most contested determinant. Productive public spending can raise growth by providing infrastructure and other public inputs (Aschauer, 1989; Barro, 1990), whereas distortionary financing, crowding out and waste can reduce it (Easterly, Rebelo, 1993; Devarajan, Swaroop, Zou, 1996). The net effect therefore depends on the composition and efficiency of spending. ARDL studies for Algeria typically find a positive long-run association between public expenditure and GDP (Smaili, Khelassi, 2021; Boultif, Rahali, 2025), but they also stress that growth remains driven by the hydrocarbon sector and that expansionary fiscal policy has not by itself secured sustained growth (Boultif, Rahali, 2025).

Trade openness is expected to raise growth through scale, competition and technology diffusion (Frankel, Romer, 1999), yet the cross-country evidence is contested and sensitive

to how openness is measured (Rodriguez, Rodrik, 2001). In resource-dependent economies, trade as a share of GDP largely reflects commodity exports, and the resource-curse literature suggests that the diversification gains from trade are then limited (Sachs, Warner, 1995; Hausmann, Hwang, Rodrik, 2007; van der Ploeg, 2011).

For Algeria itself, evidence on FDI is divided. Cherakrak, Gaham (2020) report a significantly negative effect of FDI on growth in 1990-2018, whereas Touahir (2022) reports a positive effect in the short and long run for 1980-2020, together with a positive long-run role for capital formation and government spending. More recent ARDL evidence for 1990-2023 again finds a positive and cointegrated FDI – growth relationship (Kaddouri, Benelbar, 2024), so the disagreement has not been resolved by longer samples. A further, methodological source of disagreement is that bounds tests are rarely accompanied by the checks needed when the dependent variable is stationary or the sample contains breaks (Pesaran, Shin, Smith, 2001; McNown, Sam, Goh, 2018).

Research gap. Three points follow. 1) Agreement is strongest on the sign expected for inflation and weakest for FDI, trade openness and government expenditure, where results depend on sector composition, absorptive capacity and the sample. 2) The Algerian studies reviewed here mostly concentrate on one or two determinants and on shorter samples, so their estimates are not directly comparable and may suffer from omitted variables. 3) Few of them discuss the economic size of the estimated effects, the degenerate cases of the bounds test, or the stability of the relationships over a period containing several large shocks. This paper addresses these gaps by estimating a common model for five determinants over 1980-2024, by stating hypotheses with expected signs, and by reporting economic magnitudes, the full set of bounds tests and stability checks.

3. METHODOLOGY

Research question, thesis and hypotheses. The research question is which of five macroeconomic variables are related to growth in Algeria in the long run and in the short run. The thesis tested is that, over 1980-2024, growth is linked to these variables by a level relationship with the signs implied by theory, and that the estimated effects are economically meaningful. Five hypotheses follow. H1: gross fixed capital formation (GFCF) has a positive effect on growth. H2: foreign direct investment (FDI) has a positive effect, conditional on absorptive capacity. H3: inflation (INF) has a negative effect. H4: trade openness (TO) has a positive effect. H5: government expenditure (GOVEXP) has a positive effect if spending is productive, but its sign is theoretically ambiguous because of possible crowding out, so it is tested two-sided. The null hypothesis of the bounds test is that there is no long-run (level) relationship among the variables.

Variables and their selection. Table 1 summarises the variables, their measurement and the expected signs. The set follows standard growth specifications in which capital accumulation, openness, macroeconomic stability and the size of government appear as regressors (Barro, 1991; Fischer, 1993), complemented by FDI as the main external source of capital and technology. Each variable corresponds to one of the channels discussed in Section 2 and is available for the whole period from a single source. All variables are rates or ratios to GDP, so coefficients are semi-elasticities: percentage-point changes in growth per percentage-point change in the regressor. Government expenditure is measured as general government final consumption, which excludes public investment; this matters for Algeria and is taken up in Section 5. Human capital, institutional quality, oil prices and the

exchange rate are not included in order to keep the model parsimonious for 45 annual observations; the omission is a limitation.

Table 1. Variables, measurement and expected signs

Variable	Measurement (WDI code)	Exp. sign	Theoretical rationale (main references)
EG	Annual growth of real GDP, % (NY.GDP.MKTP.KD.ZG)	—	Dependent variable
GFCF	Gross fixed capital formation, % of GDP (NE.GDI.FTOT.ZS)	+	Capital accumulation raises productive capacity (Solow, 1956; Mankiw, Romer, Weil, 1992)
FDI	Net FDI inflows, % of GDP (BX.KLT.DINV.WD.GD.ZS)	+	Technology transfer and spillovers, conditional on absorptive capacity (Borensztein, De Gregorio, Lee, 1998)
INF	Consumer price inflation, annual % (FP.CPI.TOTL.ZG)	–	Uncertainty and distorted price signals (Fischer, 1993; Bruno, Easterly, 1998)
TO	Exports plus imports of goods and services, % of GDP (NE.TRD.GNFS.ZS)	+	Scale, competition and technology diffusion (Frankel, Romer, 1999); weakened by commodity dependence
GOVEXP	General government final consumption expenditure, % of GDP (NE.CON.GOVT.ZS)	+ / –	Public inputs versus crowding out and waste (Barro, 1990; Devarajan, Swaroop, Zou, 1996)

Source: Authors' elaboration based on World Bank (2026).

Data. The study uses annual data for 1980-2024 (45 observations) for Algeria from the World Bank's World Development Indicators, retrieved through the World Bank API on 16 October 2026 (World Bank, 2026). All seven series were complete and no value was imputed. Two samples are estimated: the full sample (1980–2024) and a 1980-2020 sample (41 observations), which serves as a sensitivity check. The four observations after 2020 are too few for a separate estimation.

Order of integration. Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests (Dickey, Fuller, 1979; Phillips, Perron, 1988) are applied to levels and first differences with an intercept (ADF lag length chosen by the Akaike criterion with a maximum of four lags; PP with Newey–West bandwidth). ADF with an intercept and a trend, and the Zivot--Andrews (1992) test with one break in the intercept, are used as checks, since the usual tests have low power against stationarity with breaks (Perron, 1989). The ARDL bounds test is valid whether the regressors are I(0) or I(1), but not if any variable is I(2) (Pesaran, Shin, Smith, 2001). The unit-root tests therefore serve to rule out I(2) variables and to inform interpretation, not to select the estimator; mixed orders of integration pose no problem for the procedure itself.

ARDL specification and lag selection. The bounds-testing approach of Pesaran, Shin, Smith (2001) is based on the unrestricted error-correction form of the ARDL model:

$$\begin{aligned}\Delta \mathrm{EG}_t = \alpha_0 + \sum_{i=1}^{p-1} \beta_i \Delta \mathrm{EG}_{t-i} + \sum_{j=1}^{5} \sum_{i=0}^{q_j-1} \gamma_{ji} \Delta X_{j,t-i} \\ + \varphi_1 \mathrm{EG}_{t-1} + \sum_{j=1}^{5} \varphi_{j+1} X_{j,t-1} + \varepsilon_t\end{aligned} \tag{1}$$

where Δ is the first-difference operator, X(j), j = 1,…,5, denotes GFCF, FDI, INF, TO and GOVEXP, p and q(j) are lag orders and ε(t) is a white-noise error. The null hypothesis of no level relationship is H0: φ(1) = φ(2) = … = φ(6) = 0. Lag orders were chosen by the Akaike information criterion over all combinations with p = 1, 2, 3 and q(j) = 0, 1, 2 (729 models), evaluated on a common sample (1983–2024) so that the criteria are comparable. The selected specification is ARDL(1,0,0,0,0,1), in the order EG, GFCF, FDI, INF, TO, GOVEXP, that is, only government expenditure enters with a lagged difference. The Schwarz criterion selects ARDL(1,0,0,0,0,0), which is used as a robustness check. The same orders are used for the 1980–2020 sample.

Bounds tests and critical values. Three tests are computed from Equation (1). The overall F-test (all lagged levels, Case III: unrestricted intercept, no trend); the t-test on the lagged dependent variable (φ(1)); and the F-test on the lagged regressors alone (φ(2) = … = φ(6) = 0). Cointegration requires rejection in all three; if the F-test and the t-test reject but the F-test on the lagged regressors does not, the case is degenerate and the rejection reflects the dependent variable only (Pesaran, Shin, Smith, 2001; McNown, Sam, Goh, 2018). Because the asymptotic bounds (5%: 2.62-3.79 for the F-test with k = 5) are unreliable in samples of 41-45 observations (Narayan, 2005; Kripfganz, Schneider, 2020), critical bounds were simulated by Monte Carlo (6,000 replications) for the actual sample sizes and specification, with all regressors I(0) for the lower bound and all I(1) for the upper bound. If cointegration is found, the long-run relationship is:

$$\mathrm{EG}_t = \theta_0 + \sum_{j=1}^{5} \theta_j X_{j,t} + u_t \tag{2}$$

where the long-run coefficients are θ(j) = −φ(j+1)/φ(1), estimated with delta-method standard errors. The model can then be written in error-correction form:

$$\Delta\mathrm{EG}_t = \alpha_0 + \sum_{i=1}^{p-1} \beta_i \Delta\mathrm{EG}_{t-i} + \sum_{j=1}^{5} \sum_{i=0}^{q_j-1} \gamma_{ji} \Delta X_{j,t-i} + \lambda \mathrm{ECT}_{t-1} + \varepsilon_t \tag{3}$$

where ECT(t−1) is the lagged long-run residual and λ is the speed of adjustment, expected between −1 and 0. Model adequacy is checked with the Breusch–Godfrey, Jarque–Bera and Breusch–Pagan–Godfrey tests and the Ramsey RESET test.

Stability and robustness. Parameter stability is examined with the CUSUM and CUSUM-of-squares tests (Brown, Durbin, Evans, 1975) and with a sup-F test for a break of unknown date in the intercept, and in the intercept and the trade-openness coefficient, (Andrews, 1993) whose p-value is obtained by a fixed-regressor bootstrap with 999 replications (Hansen, 2000). The results are also re-estimated for 1980-2019, 1990-2024 and the BIC specification, with dummies for 1986-1999 (oil-price collapse, debt rescheduling and internal conflict), 2014 onwards (oil-price fall) and 2020 (pandemic), and with Newey–West standard errors (Newey, West, 1987). All computations were carried out in Python (statsmodels and arch).

Limitations of the method. The approach estimates associations, not causal effects, and with 41-45 observations the power of the tests is limited. These points are taken up in Section 5.

4. RESULTS

Descriptive statistics. Figure 1 shows growth and trade openness together with the main episodes of the period, and Table 2 reports descriptive statistics. Growth averaged 2.67% (standard deviation 2.38) in 1980-2024, with a minimum of −5.00% in 2020 and a maximum of 6.50% in 2003. In 2021-2024 it averaged 3.80% with a standard deviation of only 0.22, but this rests on four observations. Gross fixed capital formation averaged 31.34% of GDP, trade openness 53.50% and inflation 8.60%, with a peak of 31.67% in 1992. FDI is small in all periods, averaging 0.58% of GDP (maximum 1.87%), which matters for the economic significance of its coefficient. Government final consumption averaged 16.85% of GDP.

Table 2. Descriptive statistics

Variable	Period	Mean	Std. dev.	Min	Max
Economic growth (EG)	1980-2024	2.67	2.38	−5.00	6.50
	1980-2020	2.56	2.47	−5.00	6.50
	2021-2024	3.80	0.22	3.60	4.10
Gross fixed capital formation (GFCF)	1980-2024	31.34	5.83	20.68	43.39
	1980-2020	31.14	6.05	20.68	43.39
	2021-2024	33.36	2.29	30.38	35.20
Foreign direct investment (FDI)	1980-2024	0.58	0.58	−0.29	1.87
	1980-2020	0.60	0.60	−0.29	1.87
	2021-2024	0.38	0.19	0.11	0.48
Inflation (INF)	1980-2024	8.60	7.85	0.34	31.67
	1980-2020	8.71	8.19	0.34	31.67
	2021-2024	7.46	2.48	4.05	9.32
Trade openness (TO)	1980-2024	53.50	8.97	32.68	71.03
	1980-2020	54.28	8.93	32.68	71.03
	2021-2024	45.48	4.69	40.13	51.19
Government expenditure (GOVEXP)	1980-2024	16.85	2.18	11.95	20.52
	1980-2020	16.76	2.26	11.95	20.52
	2021-2024	17.73	0.82	16.54	18.43

Source: Authors' calculations based on World Bank (2026). Variables are in % (EG, INF) or % of GDP (the others).

Unit-root tests. Table 3 shows that EG is stationary in levels (ADF and PP $p < 0.01$, also with a trend and with a break). GFCF, INF and TO are I(1). FDI and government expenditure are borderline: FDI is stationary by the PP test at the 5% level and government expenditure by the ADF test at the 5% level ($p = 0.048$), but neither by the other tests, and both become stationary in the Zivot–Andrews test with a break (2011 and 2010 respectively), which suggests that part of their apparent persistence reflects level shifts. All first differences are stationary at the 1% level, so no variable is I(2) and the bounds test can be applied. Because EG is I(0), a rejection by the overall F-test alone would be uninformative, which is why the additional tests described in Section 3 are reported.

Table 3. Unit-root test results

Variable	ADF level	ADF 1st diff.	PP level	PP 1st diff.	Zivot–Andrews (break)	Classification
EG	−4.469***	−6.909***	−4.438***	−13.004***	−5.262** (1994)	I(0)
GFCF	−1.348	−5.498***	−1.659	−5.298***	−3.888 (2008)	I(1)
FDI	−1.550	−7.157***	−3.001**	−10.309***	−5.226** (2011)	Borderline
INF	−2.316	−5.908***	−1.953	−6.065***	−3.908 (1996)	I(1)
TO	−1.530	−5.848***	−2.165	−5.679***	−3.112 (2014)	I(1)
GOVEXP	−2.877**	−5.634***	−2.175	−5.150***	−5.317*** (2010)	Borderline

Source: Authors' calculations. Note: ***, ** and * denote rejection of the unit-root null at the 1%, 5% and 10% levels (Zivot–Andrews: 1% and 5% critical values −5.28 and −4.81). Intercept included; ADF lags by AIC (maximum 4).

Bounds tests. Table 4 reports the three tests against simulated finite-sample bounds. In the full sample the overall F-statistic (4.833) exceeds the 5% upper bound (4.28) and lies within the 1% bounds, and the t-statistic on lagged EG (−5.264) is beyond the 1% upper bound (−5.03). However, the F-statistic on the lagged regressors (1.465) is below even the 10% lower bound (2.06), so the null that the five regressors do not enter the level relationship cannot be rejected. This is the degenerate case in which the rejection is caused by the stationary dependent variable, and the evidence therefore does not support cointegration. In the 1980–2020 sample the F- and t-tests are inconclusive at the 5% level and the test on the lagged regressors again does not reject (1.791). With the asymptotic bounds of Pesaran, Shin, Smith (2001) the overall F-test would have indicated cointegration in the full sample ($F = 4.833 > 3.79$), which illustrates the importance of the additional tests.

Table 4. ARDL bounds tests for cointegration, ARDL(1,0,0,0,0,1)

Sample	Test	Statistic	10% bounds I(0) / I(1)	5% bounds I(0) / I(1)	1% bounds I(0) / I(1)	Decision
1980-2024	F (all lagged levels)	4.833	2.46 / 3.65	2.90 / 4.28	3.92 / 5.58	Reject (5%)
	t (lagged EG)	−5.264	−2.56 / −3.85	−2.90 / −4.21	−3.55 / −5.03	Reject (5%)
	F (lagged regressors)	1.465	2.06 / 3.59	2.51 / 4.26	3.57 / 5.90	Do not reject (5%)
1980-2020	F (all lagged levels)	3.251	2.49 / 3.71	3.03 / 4.37	4.16 / 5.80	Inconclusive (5%)
	t (lagged EG)	−3.946	−2.56 / −3.84	−2.94 / −4.23	−3.58 / −5.04	Inconclusive (5%)
	F (lagged regressors)	1.791	2.06 / 3.67	2.56 / 4.41	3.81 / 5.99	Do not reject (5%)

Source: Authors' calculations. Note: critical bounds simulated for n = 45 and n = 41 (6,000 replications, Case III, k = 5); t-test bounds are negative. For comparison, the asymptotic 5% bounds for the F-test are 2.62–3.79 (Pesaran, Shin, Smith, 2001). Cointegration requires rejection in all three tests.

Estimated model. Although the bounds tests do not support cointegration, Table 5 reports the unrestricted error-correction model, which is the estimated ARDL model, so that the dynamics can be inspected. The coefficient on lagged growth is −0.848 (t = −5.26),

implying that about 85% of a deviation is removed within a year (half-life 0.37 years). Because EG is stationary, this speed of adjustment mostly reflects the low persistence of growth rates rather than convergence to an equilibrium defined by the regressors. Among the lagged levels only trade openness is significant at the 5% level (0.126, p = 0.044). The change in government expenditure has a negative short-run coefficient (−0.542, p = 0.051), significant at the 10% level. GFCF, FDI and inflation are not significant in either sample. The adjusted R^2 of the model is 0.37, and a large part of it is mechanical, since lagged growth enters the equation for ΔEG.

Table 5. Unrestricted error-correction model (dependent variable: ΔEG)

Variable	Coef. 1981–2024	Std. err.	p-value	Coef. 1981–2020	Std. err.	p-value
Constant	−4.453	5.783	0.446	−7.372	5.836	0.216
EG(−1)	−0.848***	0.161	<0.001	−0.750***	0.190	<0.001
GFCF(−1)	−0.063	0.080	0.437	−0.098	0.081	0.239
FDI(−1)	−0.227	0.765	0.768	−0.254	0.763	0.742
INF(−1)	−0.049	0.053	0.367	−0.028	0.054	0.604
TO(−1)	0.126**	0.061	0.044	0.159**	0.063	0.016
GOVEXP(−1)	0.149	0.271	0.586	0.244	0.271	0.374
ΔGOVEXP	−0.542*	0.268	0.051	−0.491*	0.281	0.090
Observations / R^2	44 / 0.47			40 / 0.40		

Source: Authors' calculations. Note: ***, ** and * denote significance at the 1%, 5% and 10% levels.

Long-run multipliers and economic significance. Table 6 reports the long-run multipliers implied by the estimated model, with delta-method standard errors. They are shown for completeness and, given the bounds-test outcome, should be read as conditional associations rather than as equilibrium relationships. Only trade openness is significant (θ = 0.149, p = 0.033); it keeps its sign and significance in the 1980-2020 sample (0.212). The other four coefficients have standard errors larger than, or of the same order as, the coefficients themselves. Statistical and economic significance must be distinguished.

Table 6. Long-run multipliers and economic magnitude (full sample)

Variable	Long-run coef. θ	Std. err.	p-value	Effect of +1 s.d. (pp)	% of s.d. of EG	θ, 1980–2020 (p)
GFCF	−0.074	0.094	0.438	−0.43	18%	−0.130 (0.262)
FDI	−0.268	0.893	0.766	−0.15	6%	−0.338 (0.739)
INF	−0.057	0.060	0.349	−0.45	19%	−0.038 (0.589)
TO	0.149**	0.067	0.033	1.34	56%	0.212 (0.018)
GOVEXP	0.176	0.323	0.590	0.38	16%	0.326 (0.396)

Source: Authors' calculations. Note: $\theta(j) = -\varphi(j+1)/\varphi(1)$; standard deviations from Table 2; effect = coefficient × standard deviation of the regressor; ** denotes significance at the 5% level.

A one-standard-deviation change in trade openness (9.0 points) corresponds to 1.34 percentage points of growth, about 56% of the standard deviation of growth (2.38), which

is large if taken literally; the point estimates for GFCF, FDI, inflation and government expenditure imply effects of 6=19% of that standard deviation, but with confidence intervals that include zero and both signs. The large trade-openness effect should be weighed against its fragility in the robustness analysis below.

Diagnostic tests. Table 7 shows no evidence of serial correlation, non-normality or heteroscedasticity in either sample. The Ramsey RESET test rejects correct functional form in the full sample at the 5% level (p = 0.021) but not in the 1980-2020 sample (p = 0.287), which suggests that the linear specification is only an approximation, in line with the non-linearities discussed in Section 2. With 41-45 observations these tests have limited power.

Table 7. Diagnostic tests

Test	Full sample statistic	p-value	1980–2020 statistic	p-value
Breusch–Godfrey serial correlation LM test (2 lags)	0.164	0.850	0.557	0.579
Jarque–Bera normality test	1.346	0.510	0.638	0.727
Breusch–Pagan–Godfrey heteroscedasticity test	0.405	0.893	0.213	0.980
Ramsey RESET test (squared fitted values)	5.834	0.021	1.176	0.287

Source: Authors' calculations.

Robustness and structural stability. Table 8 re-estimates the model under alternative samples and specifications. Three results stand out. First, the F-test on the lagged regressors never rejects (largest value 1.79, against 5% lower bounds of about 2.5), so the absence of cointegration does not depend on the sample or lag choice. Second, the coefficient on trade openness is positive in all specifications but is not robust: it loses significance when the sample starts in 1990 (t = 1.2), falls to 0.103 (t = 1.7) when a dummy for 2020 is added and to 0.037 (t = 0.5) when the three episode dummies are included.

Table 8. Robustness of long-run multipliers and bounds tests

Specification	n	φ(1) (t)	θ TO (t)	θ INF (t)	θ FDI (t)	F lagged regressors
Baseline ARDL(1,0,0,0,0,1)	44	−0.85 (−5.3)	0.149 (2.2)	−0.057 (−0.9)	−0.268 (−0.3)	1.46
1980-2020	40	−0.75 (−3.9)	0.212 (2.5)	−0.038 (−0.5)	−0.338 (−0.3)	1.79
1980-2019	39	−0.80 (−4.6)	0.150 (2.1)	−0.061 (−1.1)	−0.179 (−0.2)	1.53
1990-2024	35	−0.92 (−4.8)	0.090 (1.2)	−0.031 (−0.5)	1.071 (1.0)	1.20
BIC specification ARDL(1,0,0,0,0,0)	44	−0.81 (−4.9)	0.146 (2.0)	−0.070 (−1.1)	−0.247 (−0.3)	1.16
With 2020 dummy	44	−0.87 (−6.1)	0.103 (1.7)	−0.076 (−1.5)	−0.137 (−0.2)	1.52
With dummies 1986-99, 2014+, 2020	44	−0.90 (−6.4)	0.037 (0.5)	−0.002 (−0.0)	−0.177 (−0.2)	0.29

Source: Authors' calculations. Note: φ(1) is the coefficient on lagged EG in the error-correction equation; t-statistics in parentheses.

The 2020 dummy is large and significant (−7.02, t = −3.4), so the openness effect is partly driven by the joint fall of trade and output in 2020 and, more generally, by the

common dependence of trade and growth on hydrocarbon prices. With Newey–West standard errors the coefficient on lagged TO has p = 0.052. Third, the other four coefficients are never significant.

The stability tests do not point to a break in the estimated relationship. The recursive CUSUM and CUSUM-of-squares statistics stay inside the 5% bands (Figure 2), the OLS-residual CUSUM test gives p = 0.937, and the sup-F test finds no break in the intercept (F = 2.37, most likely date 1990, bootstrap p = 0.598) nor in the intercept and trade-openness coefficient jointly (F = 2.45, 2006, p = 0.535). A simple intercept shift is significant at 1986 (p = 0.031) but not at 1994, 2000 or 2014 (p > 0.50); since the dates were not chosen by theory alone this is treated as suggestive only. Given the small sample, absence of evidence of a break is not evidence of stability, and the dummy results above show that episodes such as 2020 matter for the estimates.

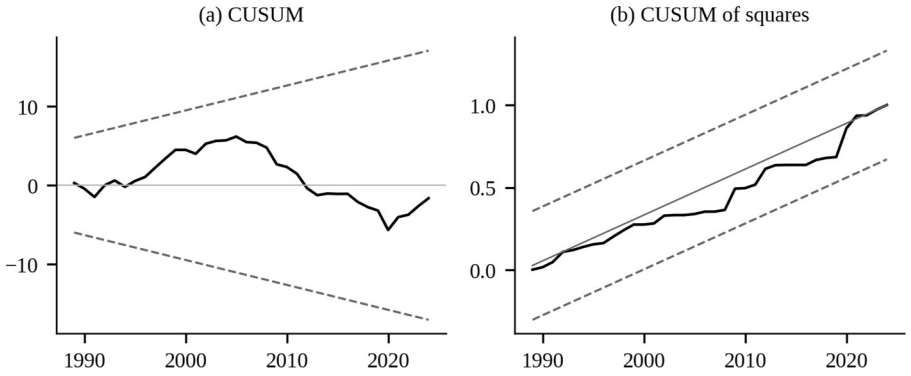


Figure 2. CUSUM and CUSUM-of-squares tests, full-sample ARDL(1,0,0,0,0,1)

Source: Authors' calculations. Note: dashed lines are approximate 5% bounds.

5. DISCUSSION

Synopsis and hypotheses. The evidence does not support a long-run level relationship between growth and the five variables: the F- and t-tests reject only because growth is itself stationary, and the F-test on the lagged regressors does not reject in any sample or specification. Table 9 compares the estimates with the hypotheses. Only the findings in the third column follow directly from the estimates; everything that follows in this section about mechanisms is interpretation.

Table 9. Hypotheses and results (full sample)

Hypothesis	Exp. sign	Long-run coefficient (p-value)	Verdict
H1: GFCF	+	−0.074 (0.438)	Not supported
H2: FDI	+	−0.268 (0.766)	Not supported
H3: INF	−	−0.057 (0.349)	Sign as expected, not significant
H4: TO	+	0.149 (0.033)	Supported at 5%, but not robust
H5: GOVEXP	+ / −	0.176 (0.590)	Not supported; short-run ΔGOVEXP: −0.542 (0.051)

Source: Authors' elaboration based on Tables 4-8.

Confrontation with previous findings. The insignificant FDI coefficient is consistent neither with the positive effects reported by Touahir (2022) and Kaddouri, Benelbar (2024) nor with the significantly negative effect of Cherakrak, Gaham (2020); it is compatible with the view that FDI in Algeria is small (0.58% of GDP on average) and concentrated in energy, so that its growth effect is hard to detect in aggregate data. Differences in sample, controls and, as shown here, in the treatment of the degenerate case of the bounds test may explain part of the disagreement, although this cannot be tested with the present data. The negative sign of inflation agrees with Fischer (1993) and with the Algerian threshold studies, but a linear model cannot identify a threshold: mean inflation (8.60%) lies above the thresholds estimated for Algeria (3.65-5.91%) and below the 11-12% estimated for developing countries (Khan, Senhadji, 2001). The absence of a long-run effect of government final consumption differs from the positive associations reported by Smaili, Khelassi (2021) and Boultif, Rahali (2025), who use different expenditure measures and periods; the negative short-run coefficient is compatible with the view that increases in current spending are not growth-enhancing.

The positive and significant trade-openness coefficient is notable given hydrocarbon dependence, but it cannot be read as evidence that diversification gains from trade have materialised. Trade-to-GDP includes hydrocarbon exports and moves with oil prices, so it may proxy the hydrocarbon cycle rather than openness as a policy; this is consistent with its disappearance once the 2020 episode is controlled for. The insignificance of GFCF is consistent with the view that the quantity of investment is a weak indicator of its productivity (De Long, Summers, 1991), but the data used here do not allow this to be tested.

Theoretical significance. The results do not confirm the neoclassical expectation of a long-run effect of capital formation, nor the endogenous-growth expectation for FDI and public inputs, and they only weakly support the openness hypothesis. The unexplained variation is large, which suggests that growth in Algeria is shaped mainly by factors outside the model, such as hydrocarbon revenues, oil prices and institutions, in line with the resource-curse literature (Sachs, Warner, 1995; van der Ploeg, 2011).

Implications. The estimates support very little by way of policy conclusions. The only findings that can be stated are that, in this sample, no long-run association of growth with investment, FDI, inflation or government consumption can be established, and that a positive association with trade openness exists but is fragile. Recommendations such as improving the quality of public investment, steering FDI to non-hydrocarbon sectors, diversifying exports, maintaining price stability and raising the efficiency of public spending follow from the literature and from the structure of the Algerian economy, not from the coefficients, because the model does not separate hydrocarbon from non-hydrocarbon FDI or trade, nor the composition of public spending. They should be treated as hypotheses for further research, not as results of this study.

Limitations. The long period (1980-2024) includes the oil-price collapse of the mid-1980s, debt rescheduling and the internal conflict of the 1990s, the hydrocarbon boom of the 2000s, the global financial crisis, the oil-price fall of 2014-2016 and the pandemic of 2020. The stability tests find no formal break, but their power is low and the dummy results show that the estimates are sensitive to 2020 and, to a lesser extent, to the 1986–1999 period. The results should therefore be treated as average associations over the whole period. Further limitations are the small sample, the omission of oil prices, institutions and human capital, the use of government final consumption rather than total spending, the

aggregate nature of the variables, the possibility of revisions to recent data, and the fact that ARDL estimates do not establish causality.

Future research. Future work should (1) include oil prices and institutional quality; (2) test for breaks with unit-root tests that allow for them (Perron, 1989; Zivot, Andrews, 1992; Lee, Strazicich, 2003) and with multiple-break tests (Bai, Perron, 2003); (3) estimate sub-periods or regime-switching and threshold models, notably for inflation; (4) separate hydrocarbon from non-hydrocarbon FDI, trade and public spending, and use total and capital expenditure; and (5) use bootstrap bounds tests designed for small samples (McNown, Sam, Goh, 2018).

6. CONCLUSIONS

This paper examined the relationship between economic growth in Algeria and five macroeconomic variables over 1980-2024 using the ARDL bounds-testing approach. The research problem was the fragmented and inconsistent evidence on growth determinants in Algeria; the objective was to estimate their short-run and long-run associations jointly, to assess their economic size and to check their stability.

The main finding is negative: growth is stationary and the test on the lagged regressors does not support a long-run relationship with investment, FDI, inflation, trade openness and government expenditure, either in the full sample or in 1980-2020. Trade openness is the only variable with a significant long-run coefficient (0.15), and it is not robust to controlling for 2020 and other episodes. FDI, inflation, capital formation and government consumption are not significant, and the change in government consumption is negatively related to growth in the short run ($p = 0.051$).

The contribution of the paper is a joint, theory-guided test of five determinants over a long sample, with full reporting of the bounds tests including the degenerate-case checks, a distinction between statistical and economic significance, and stability analysis. Its main limitations are the small sample, the low power of break tests, the omission of oil prices and institutions and the aggregate measurement of the variables. The policy implications that follow directly from the estimates are limited; broader reforms are suggested by the literature but are not established by these results.

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Declaration of AI:

During the preparation of this revised manuscript, the author used AI or AI-assisted tools to support language editing, restructuring, and refinement of the Introduction, Literature Review, Methodology, Results, Discussion, and Conclusions in response to the reviewers' comments. These tools were also used to assist with the preparation and verification of econometric tables and figures, including model re-estimation, finite-sample critical values, and stability tests, based on the dataset provided by the author. Additional assistance was used for manuscript formatting in accordance with the journal's template and for checking and formatting references, including DOI links. The author reviewed and verified the AI-assisted outputs, including the reported calculations, references, interpretations, and conclusions, and made the final decisions regarding the manuscript's content. The author takes full responsibility for the accuracy, integrity, and originality of the submitted work. The AI tools used and their respective roles are identified in the relevant sections of the manuscript, in accordance with the journal's publication ethics and disclosure requirements.

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PERCEPTION OF INFORMATION AND THE QUALITY OF DECISION-MAKING UNDER CONDITIONS OF COGNITIVE WARFARE

Purpose: The article examines how manipulated information can degrade the quality of decisions made in command and public administration under conditions of cognitive warfare. Methodology: A qualitative narrative review of a purposively selected corpus (doctrinal, cognitive-psychological and disinformation literature) is combined with content analysis and an illustrative case (Crimea, 2014). Results: The paper defines decision quality, proposes a model linking manipulated stimuli, situation awareness, judgement and outcomes, and derives five propositions. The effect of manipulated information on situation awareness under time pressure is theoretically plausible but not yet directly tested, whereas population-level effects of disinformation are often small and concentrated, and claims of lasting or collective effects are weakly supported. Contribution and implications: The model separates evidence from doctrine and yields recommendations on protecting decision processes, measuring decision quality in exercises and targeting resilience measures.

Keywords: cognitive warfare, decision quality, situation awareness, reflexive control, disinformation.

1. INTRODUCTION

Contemporary security conflicts are increasingly fought beyond the kinetic sphere. One area of rivalry is the way individuals, organisations and states perceive reality, process information and make decisions. In strategic debate, especially within NATO, this is called cognitive warfare (du Cluzel, 2020; Claverie et al., 2022). Its functional counterpart in Russian thought is reflexive control, and in Chinese thought "cognitive domain operations" (Thomas, 2004; Wojnowski, 2015; Beauchamp-Mustafaga, 2019).

The relationship between the perception of information and the quality of decisions is usually assumed in this literature rather than examined. Claims about "capturing" the decision process, "programming" an adversary or permanently changing the attitudes of whole societies are rarely supported by a defined measure of decision quality or by an explicit method. At the same time, empirical research on disinformation gives a more

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nuanced picture: alongside evidence for cognitive mechanisms that foster susceptibility to false information, there are robust findings that the measurable effects of such campaigns are often limited (Guess, Nagler, Tucker, 2019; Eady et al., 2023; Altay, Berriche, Acerbi, 2023).

The aim of the article is to organise this knowledge around one research problem: *how can manipulated information lower the quality of decisions taken in command and public administration, and what is the evidence on the scale and durability of this effect?* Four research questions follow. RQ1: how does the literature define cognitive warfare and its relation to information warfare, psychological operations and reflexive control? RQ2: how can decision quality be defined and operationalised, and how does it relate to the perception of information? RQ3: which cognitive mechanisms mediate between manipulated information and decisions, and what is the evidence for them? RQ4: what recommendations follow, and what do they add to existing NATO and EU measures?

The article contributes in three ways: it proposes a conceptual model that links information perception to decision quality through situation awareness; it separates claims that have empirical support from those that remain hypotheses; and it derives recommendations from the model rather than from general principles. Section 2 reviews the literature and presents the model, Section 3 describes the method, Section 4 reports the results, Section 5 discusses implications and limitations, and Section 6 concludes.

2. LITERATURE REVIEW

2.1. Cognitive warfare and related concepts

The multi-domain operating environment traditionally comprises land, sea, air, space and cyberspace. NATO formally recognised cyberspace as an operational domain in 2016 (NATO, 2016). The cognitive domain has no such status: it functions as an exploratory concept developed by NATO Allied Command Transformation (Deppe, Schaal, 2024), and some authors argue that a separate domain is unnecessary because psychological effects accompany action in every domain (Zilincik, 2026). The popular metaphor of domains as "transmission infrastructure" and the cognitive sphere as "payload" is applied inconsistently in the literature and is not used here. The five physical domains are treated as the space of action, whereas the informational and cognitive dimension is cross-cutting: it concerns how action in any domain is perceived and interpreted by its addressee.

The following working definitions are adopted. *Information warfare* aims to control the content and flow of information available to an addressee. *Psychological operations* are planned activities influencing the emotions, motives and behaviour of selected audiences (Olechowski, 2017). *Reflexive control* is the transmission of prepared premises to an adversary so that he voluntarily reaches a decision favourable to the initiator while believing in his own autonomy (Lefebvre, 1982; Thomas, 2004; Wojnowski, 2015). *Cognitive warfare*, in the NATO view, covers activities that influence cognition, attitudes and behaviour through the cognitive processes of the target (du Cluzel, 2020; Deppe, Schaal, 2024); the term has no single definition and is used here only as a collective name for the phenomenon whose effects on decisions are analysed.

The relation between cognitive and information warfare is contested. Du Cluzel (2020) distinguishes them by their aim: not control of content but shaping reactions to it. Others treat cognitive warfare as an evolution of psychological warfare and a part of information warfare (Olechowski, 2022), or as a concept subordinate to hybrid warfare (Hung T.-C., Hung, T.W., 2022, in: Deppe, Schaal, 2024). Zilincik (2026) argues that the concept blurs

the line between war and non-violent rivalry and that such activities are better described as attempted subversion based on specific emotions. The claim that information warfare is a "tool within" cognitive warfare is therefore one position among several. The analytical line adopted here runs by the addressee and by the stage of the decision process the action is meant to affect.

2.2. Decision quality, situation awareness and the conceptual model

The link between perception and decision in command and crisis management is situation awareness, defined by Endsley (1995) as perception of elements in the environment, comprehension of their meaning and projection of their future state. Three research traditions complement it: heuristics and biases that systematically distort judgement under uncertainty (Tversky, Kahneman, 1974; Kahneman, 2011); naturalistic decision-making, in which experts recognise a situation as a familiar pattern (Klein, 1998); and the OODA loop (Boyd, 1987), frequently invoked in the cognitive warfare literature but criticised for simplifying cognitive processes (Bryan, 2006; Zilincik, 2026).

Decision quality is defined here as the degree to which (a) the decision process – accuracy and completeness of situation assessment, consideration of options, calibration of risk and confidence, timeliness – and (b) its outcome meet a standard appropriate to the task and the information available. Process and outcome must be separated because a good decision may have a poor outcome by chance and vice versa (Keren, de Bruin, 2003); studies therefore measure process quality primarily. The model assumes the chain *manipulated stimulus → perception and situation awareness → judgement → decision-process quality → outcome quality*, moderated by time pressure, information overload, diversity of sources, verification procedures and trust in institutions (Table 1).

Table 1. Conceptual model: links, operationalisation and manipulation vectors

Link	Operationalisation (examples)	Manipulation vectors	Theoretical basis
Manipulated stimulus	Content, channel, frequency, attributed credibility of source	Disinformation, selective presentation, framing, feints	Lefebvre (1982); Thomas (2004)
Perception and situation awareness	Accuracy of situation awareness probes, levels 1-3 (e.g. scenario-freeze exercises)	Noise (perception), false frames (comprehension), false projection	Endsley (1995)
Judgement	Agreement with an expert benchmark; calibration of confidence	Availability and anchoring, emotion, persistence of corrected claims	Tversky, Kahneman (1974); Lewandowsky et al. (2012)
Process quality	Options considered, time to decision, use of verification procedures	Time pressure, overload, stoking disputes in the staff	Klein (1998); Boyd (1987)
Outcome quality	Goal attainment at acceptable cost; cost of error	Decisions aligned with the initiator's interest	Keren, de Bruin (2003)

Source: own elaboration based on the literature cited.

Five propositions follow from the model. **P1:** manipulated information lowers decision quality primarily by degrading situation awareness (levels 1-2), not by directly affecting the choice of option. **P2:** the effect is stronger under short decision time and high information load. **P3:** correcting a debunked claim reduces but does not eliminate its influence on judgement. **P4:** the effect depends on institutional moderators (verification procedures, source diversity, trust) and on the level of decision: elite and command decisions differ from mass behaviour. **P5:** measurable effects of exposure to disinformation campaigns in the population are on average small and concentrated in subgroups, which does not exclude significant consequences for selected decisions.

2.3. Cognitive mechanisms

Continued influence. False information continues to affect reasoning after it has been unambiguously corrected (Lewandowsky et al., 2012; Ecker et al., 2022). The meta-analysis by Walter and Tukachinsky (2020), covering 32 studies (N = 6,527), found that correction on average does not entirely eliminate the effect of misinformation ($r = -.05$). Corrections work better when coherent, consistent with the audience's worldview and delivered by the source of the misinformation, and worse when the misinformation was repeated, attributed to a credible source or corrected after a delay. The meta-analysis offers no basis for claims that the effect lasts 18-24 months: most studies measure effects after minutes to weeks. Ecker et al. (2022) is a narrative review, not a meta-analysis.

Framing and conceptual metaphor. Framing selects and emphasises aspects of reality so as to promote a particular problem definition, causal diagnosis, moral evaluation and remedy (Entman, 1993). Metaphors structure reasoning, so that describing migration as a "flood" suggests particular responses (Lakoff, Johnson, 2003). Analyses of framing in mainstream media (e.g. Marecki, 2012) show that the mechanism is not specific to hostile operations. Evidence that framing alone changes decisions in command comes mainly from general judgement research; military studies are scarce.

False memories and collective memory. Suggestion and misinformation can plant false elements in individual memory (Loftus, 2005). This does not justify the claim that "entire social groups remember events that never occurred": laboratory findings on individuals cannot be transferred directly to the collective level. Collective memory is shaped through conversation, institutions and cultural narratives (Hirst, Yamashiro, Coman, 2018); individual mechanisms may contribute, but require their own evidence.

Distributed cognition and emotion. Human cognition is partly external: devices and search engines serve as extensions of memory (Clark, Chalmers, 1998; Sparrow, Liu, Wegner, 2011), so the credibility of online sources affects the knowledge on which decisions rest. Emotions such as fear and anger predictably change attention, risk assessment and depth of processing, which is why Zilincik (2026) proposes analysing campaigns through specific emotions. For the model this means that "judgement" is sensitive not only to the content of information but also to its affective load.

2.4. Reflexive control and Chinese cognitive domain operations

Reflexive control derives from Soviet and Russian work on modelling decision processes (Lefebvre, 1982) and is analysed as a paradigm of Russian information-psychological operations (Thomas, 2004; Wojnowski, 2015). The literature points to concealment of real aims, simulated threats, stoking disputes around the decision-maker and influencing public moods (Wojnowski, 2015). In terms of the model, the action is interpreted as targeting "perception and situation awareness" and "process quality" and as

exploiting time pressure and overload (P1, P2); these remain theoretically plausible propositions rather than confirmed effects. Claims that the method lets a weaker actor "paralyse" a stronger one, or that the adversary "voluntarily capitulates", are doctrinal assumptions rather than findings. Evidence of effectiveness is limited and mixed: reviews of hostile information operations note difficulty in demonstrating intended effects (Wallenius, 2022), and an analysis of Russian social media operations in Donbas in 2014 points to the limits of their influence (Maschmeyer et al., 2025).

China offers the most explicit doctrinal treatment of the cognitive domain. The People's Liberation Army develops "cognitive domain operations" as a development of psychological warfare for the information age, aimed at the cognitive functions of an adversary from peacetime public opinion to wartime decisions (Beauchamp-Mustafaga, 2019; Smith, Beauchamp-Mustafaga, 2023), within the broader "Three Warfares" of public opinion, psychological and legal warfare (Halper, 2013; Kania, 2016). Practice is described mainly for Taiwan (Hung T.-C., Hung, T.W., 2022). Two differences from the Russian approach matter for the model: continuity of action in peacetime, with public opinion rather than only the decision-maker as the target, and linkage with legal and media instruments. A detailed analysis would require Chinese-language sources, which this article does not cover.

2.5. Digital media and the scale of effects

Social media are an environment of mass exposure. According to Digital 2024, social media user identities numbered 5.04 billion, about 62.3% of the world population; this is not equivalent to unique persons because one person may hold several accounts (Kemp, 2024). Average daily use was estimated at 2 h 23 min, roughly 870 hours a year of exposure to social media content, only part of which is related to manipulation. The EUvsDisinfo database recorded about 14,500 cases of pro-Kremlin disinformation in 2015-2022 (Barbaro, Skumanich, 2023); it records cases rather than "narratives" and is run by a body engaged in countering disinformation, so it is not a measure of effects. The term "infodemic" was popularised by the World Health Organization during COVID-19 (Zarocostas, 2020).

Regarding diffusion, Vosoughi, Roy and Aral (2018) found that false news on Twitter travelled farther and faster than true news: false stories were about 70% more likely to be retweeted, and true stories needed about six times longer to reach 1,500 people. The authors attribute this to human sharing driven by novelty, not to platform algorithms or bots. Against the image of disinformation as an "existential threat", Eady et al. (2023) found no measurable relationship between exposure to Russian Internet Research Agency content on Twitter and attitudes or voting behaviour in 2016, with exposure concentrated in a narrow group. Guess, Nagler and Tucker (2019) showed that sharing of fake news on Facebook is concentrated in a small minority of users, and Altay, Berriche and Acerbi (2023) point to conceptual and methodological problems in misinformation research. These results do not show that campaigns are harmless – effects may matter for particular groups, decisions or moments such as crises – but claims about lasting change in the attitudes of "whole nations" need much stronger evidence. The evidence reviewed here concerns three distinct levels: individual cognitive processes (mostly laboratory studies), population-level exposure to disinformation, and decision-making within command structures, for which direct evidence is scarce. Findings from one level are not treated here as directly interchangeable with those from another.

3. METHODOLOGY

The study is a qualitative narrative review with elements of content analysis and a short illustrative case analysis. It is not a systematic review under the PRISMA protocol and does not claim exhaustive coverage. This design reflects the problem: the concept of cognitive warfare is young and heterogeneous, and the evidence comes from distant disciplines (security studies, cognitive psychology, communication science), which hinders uniform quantitative search criteria.

The corpus was built purposively. Searches were conducted in the Scopus, Web of Science, Google Scholar, and BazTech/CEJSH databases between January and May 2026. A total of 351 records were screened. Of these, 45 sources met the criteria below and form the final corpus analysed (all are listed in the References). Publications were included if they (a) concerned cognitive warfare, information warfare or reflexive control, cognitive mechanisms relevant to perception and judgement, decision-making and situation awareness, or empirical evidence on the effects of disinformation; (b) were peer-reviewed articles and monographs or, for doctrines, official documents and institutional reports (NATO, EEAS) and analytical studies clearly labelled as such; and (c) were written in English or Polish. Student theses and press reports as a source of analytical claims were excluded. Figures from institutional reports were used only when the source document and the measurement method could be identified.

Sources were coded qualitatively along four categories derived from the model: (1) type of manipulated stimulus and channel, (2) cognitive mechanism, (3) stage of the decision process affected, and (4) type and strength of evidence (experiment, meta-analysis, observational study, doctrine, expert opinion). Coding was carried out by the author alone, using these four categories as the coding frame: each source was assigned to the relevant categories and the claims about effects were then compared across sources. No second coder was involved, so inter-coder reliability was not assessed. Claims about effects were assessed by categories 3 and 4, which separated empirical findings from doctrinal theses. The reflexive-control mechanism was illustrated by the case of Crimea (2014) based on secondary studies; the case does not test the model but shows how it can be applied, and it is not used to draw causal conclusions about particular political or military decisions. Limitations: purposive selection exposes the analysis to selection bias; restriction to two languages excludes Russian and Chinese sources in the original, so doctrines are discussed through Western and Polish studies. The conclusions therefore have the status of research propositions, not causal findings.

4. RESULTS

4.1. Assessment of the propositions

Table 2 sets the propositions against the evidence gathered in Section 2. Overall, the evidence supports only a cautious thesis: manipulation of information may plausibly degrade decision quality when it acts on situation awareness under pressure (P1 and P2 are theoretically plausible rather than directly confirmed), whereas the scale and durability of this effect are much less certain than doctrines assume.

Table 2. Propositions and the state of evidence

No.	Evidence found	Status
P1	Theoretically grounded in situation awareness research (Endsley, 1995); not tested directly in the cognitive warfare literature	Plausible; requires studies with situation awareness measurement
P2	Consistent with research on judgement under uncertainty (Tversky, Kahneman, 1974); no military studies with manipulated information as an independent variable	Plausible; untested in military settings
P3	Meta-analysis: 32 studies, N = 6,527, r = −.05 (Walter, Tukachinsky, 2020); effects typically measured over minutes to weeks	Best supported; small effect, long-term unknown
P4	Indirect support (source diversity, trust, verification); no direct tests	Indirectly supported
P5	Eady et al. (2023); Guess, Nagler, Tucker (2019); Altay, Berriche, Acerbi (2023); but mainly electoral outcomes, not command decisions	Supported for populations; not for command decisions

Source: own elaboration based on the literature cited.

4.2. Illustrative case: Crimea 2014

The case is cited in the literature as an implementation of the logic of reflexive control (Giles, 2016; Wasiuta, Wasiuta, 2017). The present description is grounded in the general findings of secondary studies. In February and March 2014 unmarked soldiers appeared in Crimea and their identity was publicly denied; Russia's authorities acknowledged the participation of its armed forces only in April 2014. According to descriptions in the literature, this ambiguity (the "manipulated stimulus") may have made it harder for Ukrainian leaders and Western partners to recognise the situation (situation awareness level 2: who is acting and with what intent) and to justify a response, while time pressure is described as having shortened the decision window (P2). Within the model, the withholding of a decision on the use of force and a delayed diplomatic response can be read as illustrations of degraded process quality. The case illustrates the model but does not prove causation: military, political and legal factors also shaped decisions, and separating them requires primary research, for instance process tracing. The interpretation of the case is therefore illustrative rather than causal: the secondary sources used do not allow particular political or military decisions to be attributed conclusively to information manipulation.

5. DISCUSSION

5.1. Synthesis and confrontation with the literature

The model organises a field in which assertion has outrun evidence. It is compatible with the view that the quality of decisions is plausibly best protected at the level of situation awareness, which is consistent with the situation-awareness tradition (Endsley, 1995), although this has not been tested directly, and it qualifies doctrinal claims in two respects. First, the durability of the continued influence effect, the lasting change of national attitudes and "collective false memories" are not established by the evidence reviewed.

Second, population-level studies (Guess, Nagler, Tucker, 2019; Eady et al., 2023) indicate that measurable effects are small and concentrated, which suggests that targeted measures may be more efficient than universal ones, although these findings concern populations and mainly electoral outcomes and cannot be transferred directly to decision-making in command structures. This agrees with sceptical positions on the analytical usefulness of the term (Zilincik, 2026) while retaining the practical question of how to protect decision processes.

5.2. Recommendations derived from the model

General recommendations (media education, information exchange, analytical centres) are largely in place: the East StratCom Task Force has operated since 2015, and NATO and the Hybrid CoE run resilience programmes. The recommendations below follow from specific links in the model; for each, the potential added value relative to existing solutions is indicated; because comparative evidence on the effectiveness of these measures is limited, these statements are tentative.

- R1. Safeguard the decision process in command and administration (from P1, P2). Introduce verification procedures for high-impact information: confirmation from independent sources, a designated devil's advocate, and limits on irreversible decisions based solely on unverified data. *Potential added value:* current efforts appear to focus on public communication and counter-narratives rather than on protecting the decision process itself; the comparative effectiveness of the two approaches has not been established.
- R2. Measure decision quality in exercises (from Section 2.2). Include scenarios with manipulated information in staff exercises and decision games, with measurement of situation awareness and process quality. *Potential added value:* could help to create the evidence base that is missing and may be a condition for assessing other measures.
- R3. Targeted, evidence-based societal resilience (from P5). Since sharing of disinformation is concentrated in a small group, targeted interventions, such as psychological inoculation (prebunking) and accuracy prompts, may be more effective than universal ones (Roozenbeek et al., 2022; Pennycook et al., 2021), although this evidence comes mainly from online and social-media studies and its transferability to other settings, including command structures, has not been demonstrated. *Potential added value:* could match interventions to the distribution of the phenomenon rather than assuming it is universal.
- R4. Integrate with existing structures instead of a new "domain". Protection of decision processes could be better embedded in strategic communication and crisis management rather than in separate structures for "defence of the cognitive domain", whose legal and doctrinal status remains disputed (Deppe, Schaal, 2024; Zilincik, 2026).
- R5. Implementation conditions and effectiveness monitoring. Measures in the information sphere are limited by law, in particular freedom of expression (Article 10 of the European Convention on Human Rights), so resilience should rest on strengthening audiences' capacities, not on censorship. Each programme needs predefined effectiveness indicators (e.g. changes in situation awareness probes and confidence calibration) and a review after a set time.

5.3. Limitations and future research

The article is a narrative review with purposive selection and no primary data; the model has not been tested empirically. Russian and Chinese doctrines are discussed on the basis of Western and Polish studies, the Crimea case is illustrative and based on secondary sources, and part of the sources (institutional reports, analytical studies) have not undergone peer review. Future research should include: (1) scenario experiments with officers or cadets in which the quality of information is manipulated and situation awareness and decision-process quality are measured; (2) process-tracing case studies of documented operations (Crimea 2014, campaigns around February 2022); (3) a systematic PRISMA review; (4) studies of collective memory in the context of information campaigns; (5) extension to Chinese doctrines using original-language sources.

6. CONCLUSIONS

In answer to the research questions: (RQ1) cognitive warfare is a contested concept overlapping with information warfare and psychological operations, and the addressee and the stage of the decision process are a useful analytical dividing line; (RQ2) decision quality can be defined as the quality of process and outcome and operationalised through situation-awareness indicators and calibration of judgement; (RQ3) the mediating mechanisms include the continued influence of corrected misinformation, framing and metaphor, emotion and distributed cognition, but evidence for their scale in real conditions is limited, and extending individual false memory to collective memory is not warranted; (RQ4) recommendations concern protecting the decision process, measuring decision quality, targeted societal resilience and integration with existing structures.

The importance of the study lies in shifting the debate from the spectacular but weakly evidenced claims of doctrines to testable propositions about decision quality. For practice, the main message (tentative, pending empirical testing of the model) is that investment should go first into the robustness of decision processes in command and administration and into measuring their quality, and only then into broad, universal campaigns.

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EXPLORING THE ROLE OF COMPETITION AND DIVERSIFICATION STRATEGY IN DRIVING BUSINESS SALES GROWTH IN AFRICA'S CONSUMER GOODS INDUSTRY

Africa's consumer goods industry has experienced significant shifts in consumer behaviour, market competition, and supply chain dynamics, intensified by the COVID-19 pandemic. These changes have heightened the need for firms to adopt effective competition and diversification strategies to sustain business sales growth. This study examined the influence of diversification capability on the sales growth of selected consumer goods firms listed on the Nigerian Exchange Group (NGX). A cross-sectional survey design was adopted, covering employees and management staff from seven leading listed consumer goods firms. From a target population of 22,466, a sample of 491 respondents was selected using proportionate stratified sampling, achieving a 97.76% response rate. Data were analysed using descriptive statistics and regression analysis. The findings revealed that diversification capability significantly and positively influenced business sales growth ($\beta = 0.842$, $t = 29.782$, $p < 0.05$). The study concludes that strategic diversification strengthens competitive positioning and recommends its adoption to achieve sustainable sales growth within Africa's evolving consumer goods industry.

Keywords: competitive advantage, FMCG, diversification strategies, organizational performance.

1. INTRODUCTION

The primary challenge posed by these dynamic environments is heightened competition, whereas business strategy serves as the means to achieve long-term objectives and goals despite such hurdles. Diversification is an essential business strategy utilised by numerous enterprises to enhance business sales growth, market share, growth rate, mitigate risk, and prolong the business life cycle (Enobong, Ekpenyong-Effa, Obong, Hammed, Isong, 2022; Gerdoçi, Busho, Lena, Cucculelli, 2023; Sindhu, Ehtasham-Ui-Haq, Sajid Ali, 2014; Yaya, Suryanto, Abubakar, Kasim, Raimi, Irfana, 2022). Amidst the prevailing

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obstacles and post-pandemic adversities in the Nigerian economy, substantial volumes of raw materials essential for the consumer products industry are procured via importation rather than domestically through the agricultural sector. Regrettably, the instability in governance, adverse market conditions, and supply limitations compel the importation of these locally sourced raw materials, resulting in increased costs and delays. Alongside the stagnation of market growth in the business, there exists a deficiency in market development. Several of these organisations are underperforming due to an absence of a diversification plan to pursue new, more lucrative markets. In response to alterations in market dynamics, competitive pressures, the repercussions of COVID-19, economic volatility, consumer attitudes, subpar business performance, and fluctuating customer expectations, enterprises necessitate diversification, behavioural modifications, and strategic realignments, usinesses are currently exerting considerable effort to create strategies that will enable them to sustain their market position while increasing their market share and earnings. Business outcomes in the consumer goods sector are predominantly influenced by consumer behaviour. Recently, both demand and supply have encountered shocks due to ongoing economic uncertainty and the adverse effects of the COVID-19 epidemic on the global economy (Nyaingiri, Ogollah, 2015; Walumweya, Phiri, 2022).

Furthermore, demand growth and consumer patronage have diminished due to the enforced decrease in demand and corresponding rise in supply. The incidence of impulse purchasing among the vast mass of customers has persistently diminished. Nigerian companies persist in adhering to traditional business practices rather than embracing diversification or other competitive measures to ensure sustainability. Research has been conducted across various countries, yet the contexts of these studies differ significantly (Adekunle, Hillary, Binuyo, 2019; Bhatia, Thakur, 2018; Dirisu, Oluwole, Ibidunni, 2013; Enobong, Ekpenyong-Effa, Obong, Hammed, Isong, 2022; Farida, Setiawan, 2022; Gbolagade, Adesola, Oyewale, 2013; Kwon, Bae, Park, 2018; Oladimeji, Udosen, 2019; Mutinda, Mwasiaji, 2018; Matekenya, Moyo, 2022; Nyaingiri, Ogollah, 2015; Parnell, Brady, 2019; Porter, 1985; Nyaberi, 2021; Santarelli, Tran, 2015; Setianto, 2020; Schommer, Richter, Karna, 2019; Sindhu, Haz, Ali, Ali, 2014). In addition to the aforementioned changes, prior research on diversification potential and business sales growth predominantly focused on developed economies and under varying environmental conditions. Previous research suggests that diversification capabilities does not inherently result in enhanced performance or sales growth, and not all diversified entities achieve profitability (Manyuru, Wachira, Amata, 2017; Sindhu, Haz, Ali, Ali, 2014). Kabuoh, Moibi Ademilua, Sunmola (2020); Karaev (2023); Kharub, Mor, Rana (2022); Matekenya, Moyo (2022); Sharma (2020); Wangui, Kifleyesus, Mote (2021) regarding small and medium-sized enterprises (SMEs) and the manufacturing sector (Ates, 2022; Gerdoçi, Busho, Lena, Cucculelli, 2023; Kharub, Mor, Rana, 2022; Kowo, Sabitu, Adegbite, 2018; Monika, Richter, Amit, 2019;). Given the theoretical and practical importance of diversification capability, the ambiguous evidence regarding its relationship with business sales growth compels the researcher to reevaluate the issues surrounding diversification capability within the context of emerging economies, particularly Nigeria. The principal aim of a company's diversification ability is to enhance the performance and revenue of its new product. Nonetheless, its impact on corporate value remains contentious in academic literature, and research investigating the influence of diversification competence on firm sales growth in the post-COVID-19 era, particularly in emerging economies such as Nigeria, is few. This article aims to address the gap by offering background information on

diversification capability related to business sales growth and analysing the link within selected publicly listed consumer goods companies in Nigeria, the most populous and largest country in Africa. The aim of this study is to examine the impact of diversification capabilities on the sales growth of chosen publicly listed consumer products companies in Nigeria.

2. LITERATURE REVIEW

2.1. Diversification Capability

Diversification has emerged as a prevalent strategy among consumer products and manufacturing enterprises seeking to outpace competitors (Omaliko, Okpala, 2022). A multitude of researchers have proposed definitions and measurements for diversification capability in company. Diversification, as defined by El Anshasy and Khalid (2022), occurs when an organisation seeks to alter its business scope by creating new goods or entering new markets, either independently or through collaboration. Krishnan (2017) describes diversification as a firm's extent of product and market engagement, whilst Arte and Larimo (2022) characterise it as the penetration into new markets with novel products. Numerous scholars perceive diversification as the strategy of incorporating related or analogous product/service lines into the existing core business, either via the acquisition of competitors or through the internal development of new products/services, thereby suggesting an enhancement of managerial competence within the firm. Diversification is a corporate-level strategy employed by organisations to sustain competitiveness and improve business sales growth (Arte, Larimo, 2022; Setianto, 2020; Oladimeji, Udosen, 2019). Research indicates that diversified organisations have superior performance and has the capacity for longevity in the corporate landscape (Adamu, Zubairu, Ibrahim, Ibrahim, 2011; Monika, Richter, Amit, 2019; Omaliko, Okpala, 2022).

2.2. Sales Growth

No enterprise or organisation can expand beyond the demand for its products or services. Any enterprise that has acquired a competitive advantage in the production of a particular products or service can utilise that advantage to penetrate new markets (Porter, 1980). Sales growth is the continual increase in product sales driven by the ongoing satisfaction of customer needs and preferences, which are consistently addressed due to the variability in their tastes and trends influenced by the changing dynamics of technology. Sales growth is an essential statistic for evaluating the performance of consumer products enterprises, as noted by Cesinger, Gundolf, and Géraudel (2018) and Mishra and Soumya (2018). Amoako-Gyampah and Acquaah (2008) characterise sales growth as an augmentation in sales and monetary value. Sales growth is an essential indicator of a business's vitality and ability to sustain operations. Sales growth is a strategic indicator employed by entrepreneurs to inform choices and assess the efficacy of sales personnel over time, as noted by Flamholtz (1986). The researchers contended that organisations risk being outpaced by competitors in the market if sales do not increase. Sales growth correlates with market share. For consumer products firms to enhance their sales growth, it likely indicates an expansion of their market share.

3. THEORETICAL REVIEW

3.1. Theory of Competitive Strategy

Porter (1998) defines competitive strategy as the endeavour to attain a favourable competitive position within an industry, which is the principal domain of competition. As these obstacles to imitation progressively diminish, the corporation must persist in investing to sustain or augment its positioning advantage to guarantee its ongoing sustainability. A company's competitive strategy will be dictated by its ability to create and sustain a competitive edge. Competitive advantage refers to the circumstances that allow a company to function more efficiently or effectively than its rivals, leading to benefits for that company (Gerdoçi, Busho, Lena, Cucculelli, 2023). The plan fundamentally entails identifying your business's desired trajectory and the means to achieve it. A precise definition hinges on competitive advantage, which is the primary purpose of most company strategies. A firm's competitive advantage arises when the value it generates for its consumers surpasses the cost of its production. Superior value is attained by presenting cheaper costs than competitors for comparable benefits or by delivering unique advantages that sufficiently justify a higher price. Cost leadership and differentiation represent the two primary forms of competitive advantage (Porter, 1985). The relative standing of a company within an industry is dictated by its choice of competitive advantage (cost leadership versus distinctiveness) and competitive scope. Competitive scope differentiates between enterprises that focus on extensive industry segments and those that concentrate on a specific section. Generic strategies are beneficial since they establish strategic positions at the most fundamental and overarching level. Porter asserts that to attain a competitive advantage, a company must determine the nature and breadth of such advantage. Each generic technique entails distinct dangers; yet, “attempting to cater to all” inevitably leads to mediocrity “becoming ensnared in the middle”. Drucker (2015) asserts. While Porter's Competitive Strategy Theory explains how firms achieve competitive advantage through strategic positioning, it provides limited explanation of how organisations continuously adapt their strategic capabilities under conditions of rapid environmental change. Dynamic Capabilities Theory complements Porter's framework by explaining the organisational processes through which firms sense opportunities, seize emerging market prospects, and transform existing resources into new competitive advantages. Together, the two theories provide a comprehensive explanation of how diversification capability contributes to sustained business sales growth in Africa's consumer goods industry.

3.2. Dynamic Capabilities Theory

Dynamic Capabilities Theory, originally developed by Teece, Pisano, and Shuen (1997) and subsequently expanded by Teece (2007), explains how organisations build, integrate, and reconfigure internal and external competencies to respond effectively to rapidly changing business environments. Unlike traditional resource-based perspectives that emphasise possession of valuable resources, Dynamic Capabilities Theory focuses on an organisation's ability to continuously renew and transform its strategic capabilities in response to environmental turbulence. Diversification capability represents one such dynamic capability because it enables firms to develop new products, enter new markets, reconfigure business portfolios, and respond proactively to changing customer preferences and competitive pressures. In post-pandemic markets characterised by uncertainty, supply chain disruptions, and changing consumer behaviour, firms possessing stronger diversification capabilities are more likely to sustain business sales growth and competitive

advantage. Consequently, Dynamic Capabilities Theory provides an appropriate theoretical lens for explaining how diversification capability contributes to organisational performance under conditions of environmental change. While Porter's Competitive Strategy Theory explains how firms achieve competitive advantage through strategic positioning, it provides limited explanation of how organisations continuously adapt their strategic capabilities under conditions of rapid environmental change. Dynamic Capabilities Theory complements Porter's framework by explaining the organisational processes through which firms sense opportunities, seize emerging market prospects, and transform existing resources into new competitive advantages. Together, the two theories provide a comprehensive explanation of how diversification capability contributes to sustained business sales growth in Africa's consumer goods industry. Guided by Dynamic Capabilities Theory, this study conceptualises diversification capability as a strategic organisational capability that enables firms to adapt to evolving market conditions through product, market, and business diversification. Such adaptive capability is expected to strengthen competitive positioning and ultimately enhance business sales growth among listed consumer goods companies in Nigeria.

4. EMPIRICAL REVIEW

4.1. Relationship between Diversification Capability and Sales Growth

Numerous contemporary and historical research have articulated scholarly discourse to elucidate the influence of diversification capabilities on the sales growth of enterprises across various situations. The empirical evidence regarding the influence of diversification on sales growth and performance is inconclusive. Some research indicates that diversification into related product markets results in superior returns and sales growth compared to diversification into unrelated markets, however other studies argue that less diverse businesses outperform those that are highly diversified. Njuguna, Kwasira, and Orwa (2018) and Hasby, Buyung, and Hasbudin (2017) assert that diversification is a strategy employed by organisations to enhance performance. To sustain growth throughout the maturity phase, corporations may seek to expand globally into less developed areas. If this is not the primary focus, such enterprises may need to diversify into several industries. A study by Yigit and Akpinar (2016) examined the correlation between diversification strategy and organisational success in Italy, the Netherlands, and Turkey, with a total population of 556 from 2007 to 2011. The Entropy Index, Return on Assets, and Return on Stock were employed to assess diversification strategy and performance, respectively. In Italy and the Netherlands, no association exists between total entropy and performance criteria; conversely, Turkey exhibits a weak positive link between total entropy and performance. Eukeria and Favourate (2014) discovered a positive correlation between diversification and profitability in their study. Hoskisson and Perig (2005) and Wan (2011) demonstrated in their research that diversification enhances profitability; conversely, investigations conducted by Omosa, Muya, Omari, and Momanyi (2022) indicated a negative correlation, suggesting that diversification diminishes performance regarding profitability. Monika, Richter, and Amit (2019) presented empirical evidence indicating that there is no correlation whether positive, negative, or quadratic between diversification and company performance. Munyiri (2014) examined customer retention and competitive strategies within Kenyan commercial banks. This study aimed to assess the impact of competitive strategies on customer retention. The study employed a descriptive survey design, targeting all forty-four registered commercial banks in Kenya.

The drop-and-pick later method was employed to gather data using copies of the questionnaire. The study's findings indicate a significant correlation between cost leadership approach and customer retention. Furthermore, banks developed new products that met market demands while simultaneously appealing to average customers through the competitive pricing of their existing offerings. The banks implemented differentiation strategies by offering their clients superior, high-quality goods and services. Concerning focus strategy, banks developed products tailored to a certain market niche, demonstrating a quantifiable correlation between client pleasure and retention in the banking sector. Applying the conclusions of this study to the setting of commercial banks is problematic due to the distinct challenges they face compared to the public service vehicle business. Consequently, this study sought to bridge the gap and hypothesized thus:

H_{o1}: There is no significant relationship between diversification capability on business sales growth of selected companies listed in Nigeria post-pandemic.

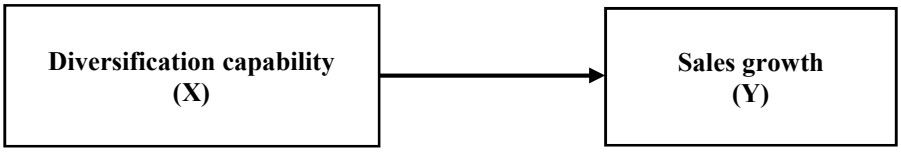


Figure 1. Conceptual Model

Source: Author's Designed Conceptual Model (2024).

The figure 1 is a model designed by the author to shed more light on the conceptualized relationship between diversification capability and business sales growth, which is the research framework. The independent and dependent variables for this research are diversification capability (X) and business sales growth (Y) respectively.

5. METHODOLOGY

The research context encompasses publicly traded consumer products companies, and the study employed a survey research design. The rationale for implementing the survey is in its efficacy in evaluating the thoughts, opinions, and emotions of diverse groups, hence facilitating more valid and candid feedback regarding the subject of inquiry. This paper relied on the prior study methodology of Olowoporoku, and Olubiyi (2023); Arokodare, and Olubiyi (2023); Makinde, Olubiyi, and Ogundipe (2023); Olubiyi (2024a); Olubiyi (2024b); Omoyele et al. (2023); Olubiyi and Akpa (2023); and Olubiyi, Lawal, and Adeoye (2022); and with cross-sectional have adopted this method in their respective studies and found it useful. The research population comprised regular employees, as well as top and middle-level managers, in the listed consumer products companies on the Nigerian Stock Exchange, currently known as the Nigeria Exchange Group (NGX). The study focused on consumer products companies in Nigeria, driven by intense competition, multinational operations, a substantial population, and the availability of data. Nigeria is the largest economy on the continent, with its people constituting twenty percent of Sub-Saharan Africa's total population. This study chose seven (7) of the twenty (20) consumer products companies registered on the Nigerian Stock Exchange, currently known as Nigeria Exchange Group, from the population. This is predicated on the capitalisation criteria obtained by multiplying the closing share price on July 31, 2024, by the number of shares outstanding, in addition to the trend in dividend payments. BUA Foods Plc, Nestle Nigeria

Plc, Nigerian Breweries, Dangote Sugar, Guinness Nigeria Plc, Flourmills Nigeria Plc, International Breweries, and Unilever Nigeria Plc constitute the seven (7) most capitalised consumer goods firms listed on the Exchange, all of which have maintained a consistent record of dividend disbursements. The rationale for the decision was that the seven companies account for 93.08% of the sector's total market capitalisation of N4.69 trillion, with each company exceeding N100 billion in capitalisation as of the cutoff date of 31 July 2023. The sampling units comprise regular employees and upper and middle management of the chosen consumer goods firms listed on the Nigerian Stock Exchange. The workforce consisted of 22,466 employees from the largest consumer products firms. The Research Advisors Table was utilised to ascertain the sample size, resulting in 491 respondents, and proportionate sampling was employed to determine the number of responses per company.

6. DATA ANALYSIS

The response rate is the ratio of individuals that responded and finished the survey questionnaire. The researcher distributed 491 copies of the questionnaire to the subjects. Of the 491 questionnaires distributed by the researcher and trained research assistants, 480 were completed and returned for analysis, resulting in a response rate of 97.76%. The remaining items were either unreturned or devoid of responses; the details of the responses are illustrated in Table 1.

Table 1. Response Rate

Response Rate	Frequency	Percentage
Fully filled and returned	480	97.76%
Incomplete or unreturned	11	2.24%
Total	491	100%

Source: Researcher's computation (2024).

Restatement of Research Objective and Research Question

Objective: Examine the effect of diversification capability on sales growth of selected listed consumer goods companies in Nigeria.

Research Question: What is the effect of diversification capability on the sales growth of selected listed consumer goods companies in Nigeria?

The objective of the study examines the effect of diversification capability on the sales growth of selected listed consumer goods companies in Nigeria. The respondents were required to rate their level of responses pertaining to diversification capability and sales growth on a scale of (Very Low) to 6 (Very High). The results are presented in Tables 2 and 3 followed by an analysis and interpretation.

Table 2 presents a descriptive examination of diversification capabilities across selected consumer products companies listed in Nigeria. The results indicated that 15.1% of respondents reported a Very High engagement in new business areas related to their existing operations over the past five years, 36.8% reported High engagement, 31.2% reported Moderately High, 4.5% reported Moderately Low, 9.2% reported Low, and 3.3% reported Very Low engagement in such ventures. The respondents, on average, provided a Moderately High rating, indicating that over the previous five years, their organisations had explored new business domains relevant to their existing operations (Mean = 4.34,

Standard Deviation = 1.251). Additionally, 5.3% of respondents indicated a Very High level of agreement that their organisations have developed products for new markets in the past five years, 41.8% indicated High, 29.4% Moderately High, 10.7% Moderately Low, 8.3% Low, and 4.5% Very Low. The respondents, on average, provided a Moderately High rating for their organisations' development of products for new markets over the past five years (Mean = 4.12, Standard Deviation = 1.209). Furthermore, 20.2% of respondents indicated a Very High perception that their organisations have invested in new business over the past five years, 37.4% rated it as High, 19.3% as Moderately High, 13.1% as Moderately Low, 7.7% as Low, and 2.4% as Very Low regarding their organisations' investments in new business during the last five years. The respondents, on average, provided a Moderately High assessment about their organisations' investments in new business during the past five years (Mean = 4.42, Standard Deviation = 1.289). Additionally, the findings indicated that 25.5% of respondents reported a Very High level of engagement in new business areas unrelated to existing operations over the past five years, 25.2% reported High, 14.5% Moderately High, 21.1% Moderately Low, 10.4% Low, and 3.3% Very Low engagement in such ventures during the same period. The respondents, on average, provided a Moderately High rating, indicating that over the previous five years, their organisation has explored new business areas unrelated to existing operations (Mean = 4.25, Standard Deviation = 1.462). The cumulative mean score for this segment is 4.28, with a standard deviation of 1.303. This indicates that, on average, the respondents provided a Moderately High assessment about the diversification capability inside their organisations.

Table 2. Descriptive Statistics of Respondents Responses on Diversification Capability

Statements	Very High	High	Moderately High	Moderately Low	Low	Very Low	Mean	Standard Deviation
Ventured into new business in the last five years	51 15.1%	124 36.8%	105 31.2%	15 4.5%	31 9.2%	11 3.3	4.34	1.251
Made products for new markets in the last five years	18 5.3%	141 41.8%	99 29.4%	36 10.7%	28 8.3%	15 4.5%	4.12	1.209
Investing in new business in the last five years	68 20.2%	126 37.4%	65 19.3%	44 13.1%	26 7.7%	8 2.4%	4.42	1.289
Ventured into unrelated business in the last five years	86 25.5%	85 25.2%	49 14.5%	71 21.1%	35 10.4%	11 3.3%	4.25	1.462
Grand Mean							4.28	1.303

Source: Field Survey Results (2024).

Table 3. Descriptive Statistics of Respondents' Response on Sales Growth

Statements	Very High	High	Moderately High	Moderately Low	Low	Very Low	Mean	Standard Deviation
Ability to surpass market demand	61 18.1%	124 36.8%	82 24.3%	27 8.0%	35 10.4%	8 2.4%	4.37	1.292
Sales output compared to competitors'	27 8.0%	153 45.4%	86 25.5%	29 8.6%	28 8.3%	14 4.2%	4.24	1.231
Amount of output produced in the last five years	92 27.3%	112 33.2%	63 18.7%	36 10.7%	28 8.3%	6 1.8%	4.55	1.313
Sustain substantial increases in their annual profits year after year	70 20.8%	111 32.9%	66 19.6%	61 18.1%	25 7.4%	4 1.2%	4.38	1.267
Grand Mean							4.39	1.276

Source: Field Survey, 2024.

Table 3 presents a descriptive examination of several publicly traded consumer goods firms in Nigeria. The data indicated that 18.1% of respondents rated their ability to exceed market demand during the past five years as Very High, 36.8% as High, 24.3% as Moderately High, 8.0% as Moderately Low, 10.4% as Low, and 2.4% as Very Low. The respondents, on average, provided a Moderately High rating about their capacity to exceed market demand over the past five years (Mean = 4.37, Standard Deviation = 1.292). Additionally, 8.0% of respondents indicated a Very High perception that their organization's sales output surpasses that of competitors, 45.4% reported a high perception, 25.5% a Moderately High perception, 8.6% a Moderately Low perception, 8.3% a Low perception, and 4.2% a Very Low perception about their organization's sales output in comparison to competitors. The respondents, on average, indicated a Moderately High belief that their organization's annual earnings surpass those of their competitors (Mean = = 4.24, standard deviation = 1.231). Furthermore, 27.3% of the respondents rated their organization's output during the past five years as Very High. 33.2% High, 18.7% Moderately High, 10.7% Moderately Low, 8.3% Low, and 1.8% Very Low on their organization's output over the past five years. The respondents provided Moderately High ratings about the output produced by the organisations over the past five years (Mean = = 4.55, Standard Deviation = 1.313). Additionally, the findings indicated that 20.8% of respondents rated the organization's capacity to maintain significant annual sales growth as Very High, 32.9% as High, 19.6% as Moderately High, 18.1% as Moderately Low, 7.4% as Low, and 1.2% asserted that the organisation sustains substantial increases in sales output year after year. The respondents reported a Moderately High level of sustained annual improvements in their sales output (Mean = 4.38, Standard Deviation = 1.267). The cumulative average score for this section is 4.39, with a standard deviation of 1.276. This indicates that, on average, the respondents provided a Moderately High response, suggesting that organisations experience significant annual improvements in their sales output. Analysis of Tables 2.1 and 2.2 indicates that diversification capabilities and sales

growth exhibit a parallel trend of expansion. Respondents said that the most diverse diversification capability employed by selected listed consumer goods businesses in Nigeria was their entry into new business areas unrelated to their existing operations over the past five years. An efficient variation of 34.4% was succeeded by the implementation of a strategy to invest in both related and unconnected new business areas, which exhibited a coefficient of variation of 29.16%. The use of these techniques has allowed the organisations to achieve their annual profit objectives, which exhibited a coefficient of variation of 29.9%. The results indicate that diversification competence may influence the profitability of some publicly listed consumer goods companies in Nigeria. These findings address the second study question and facilitate the attainment of the second aim as well.

Restatement of Hypothesis (Ho): Diversification capability has no significant effect on sales growth of selected listed consumer goods companies in Nigeria.

To test the hypothesis simple regression analysis was used where the values of sales growth of selected listed consumer goods companies in Nigeria were regressed on the values of diversification capability. The results of regression analysis for the hypothesis are shown in Table 4.

Table 4. Summary of Regression Analysis between Diversification Capability and Sales Growth

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.121	0.498		6.271	0.000
	Diversification capability	0.842	0.028	0.852	29.782	0.001
R = 0.852; R2 = 0.726; F (1,335) = 886.1						

Source: Field Survey, 2024.

Dependent Variable: Sales Growth

The results indicate that higher levels of diversification capability are associated with improved sales growth among selected publicly listed consumer goods companies in Nigeria. Firms exhibiting stronger diversification capability also reported higher levels of sales growth, suggesting that diversification serves as an important strategic driver of business expansion. The regression results demonstrate that diversification capability exerts a statistically significant and positive effect on business sales growth ($\beta = 0.842$, $t = 29.782$, $p < 0.05$). The positive coefficient indicates that firms with stronger diversification capability experience significantly higher levels of sales growth. The t-value was 29.782, and the matching p-value was 0.001, indicating statistical significance. Table 4 indicates a correlation value (R) of 0.842, suggesting a robust positive association between diversification competence and sales growth among selected listed consumer products companies in Nigeria. The coefficient of determination was significant ($R^2 = = 0.726$, $F = 886.997$, $p < 0.05$). Diversification capabilities accounted for 72.6% of the variance in sales growth among selected listed consumer goods companies in Nigeria. The other unidentified variables accounted for the remaining 27.4%. The model's analysis

yielded a F value of 886.997 and a p-value of less than 0.05. The findings corroborated the hypothesis on the impact of diversification, indicating that diversification capabilities significantly influenced the sales growth of selected publicly listed consumer products companies in Nigeria. The regression equation obtained from the output is:

$$SG = 3.121 + 0.842DC \quad \text{(eq.i)}$$

Where:
SG = Sales Growth,
DC = Diversification Capability.

The regression equation indicates that, with diversification capabilities held constant, the sales growth value for selected listed consumer goods companies in Nigeria was 3.121. Table 4 indicates that the coefficient of diversification capability was 0.842. A unit change in diversification capabilities will yield an increase of 0.842 in the sales growth of chosen publicly listed consumer goods companies in Nigeria. The coefficient and p-value for diversification competence ($\beta = 0.842$, $t = 29.782$, $p < 0.05$) indicate that diversification capability is a strong predictor of sales growth for selected listed consumer products companies in Nigeria. The findings led to the rejection of the null hypothesis (Ho), which posits that diversification capability does not significantly influence sales growth in selected listed consumer goods companies in Nigeria.

7. DISCUSSION

This study aimed to investigate the impact of diversification capability on the sales growth of selected publicly listed consumer goods companies in Nigeria. The hypothesis findings indicate that diversification competence substantially influences the sales growth of selected publicly listed consumer goods companies in Nigeria. This conclusion also corroborates the research conducted by Eukeria and Favourites (2014) in Creek manufacturing enterprises, which identified a favourable correlation between diversification and sales growth. This aligns with the research of Hasby, Buyung, and Hasbudin (2017), Hoskisson and Peng (2005), Wan (2011), Manyuru, Wachira, and Amata (2017), and Karaev (2023), which shown that diversification and competitive strategies enhance sales growth and profitability. Moreover, these results align with the research of Dimitrov and Tice (2006) and Kuppuswamy and Villalonga (2010), which indicated that elevated levels of diversification enhance sales growth, profitability, and shareholder value. Tongli, Ping, and Chiu (2005) discovered that excessive diversification negatively impacts profitability and sales development, however Masulis, Wang, and Xie (2007) identified that the traits prompting enterprises to diversify may also lead to their devaluation. Nonetheless, the discovery contrasted the findings of Maksmovic and Phillip (2007) and Ozbas and Scharfstein (2010), which revealed a negative correlation between diversification strategy and firms' sales growth, indicating that diversification diminishes performance regarding sales growth and profitability. Santalo and Becerra (2004) empirically established that no correlation exists between the two variables. The relationship between diversification and sales growth of companies is either positive, negative, or quadratic. Santalo and Becerra (2008) and Stowe and Xing (2006) similarly established that empirical evidence remains inconclusive; the model's perspectives and outcomes vary according to the researcher's disciplinary viewpoint. Furthermore, the

relationship between diversification and sales growth is intricate and influenced by intervening or contingent variables, including related versus unrelated diversification and the mode of diversification.

8. CONCLUSION AND RECOMMENDATION

The study found that diversification capability exerts a significant and positive influence on business sales growth among selected listed consumer goods companies in Nigeria. Firms that effectively diversify into new products, markets, and business opportunities are more likely to achieve sustained sales growth and strengthen their competitive position within the industry. The study's major findings indicated that diversification capability exerted a significant and favourable influence on business sales growth ($\beta = 0.842$, $t = 29.782$, $p < 0.05$). The study's findings indicated that diversification capability significantly influences the business sales growth of consumer products companies in Nigeria. Consequently, Management of consumer goods firms should strengthen diversification capabilities by expanding into complementary products, new customer segments, and emerging markets. Strategic diversification should be integrated with competitive positioning to stimulate sustainable sales growth and long-term organisational competitiveness. The report advises consumer products companies to develop and execute competitive strategies. Furthermore, cultivate attitudes that enable organisations to identify and leverage effective competitive strategies to achieve a competitive edge, thereby facilitating business expansion. An integration model for supply chain management is essential at the corporate strategy level to ensure the seamless flow of information from suppliers to the consumer point of sale. This study advocates for collaboration between the consumer products industry and universities, as well as other academic and research organisations, to address challenges and create optimal solutions for strategic management. Current and potential enterprises and organisations should contemplate the implications of this research by acknowledging and adopting its conclusions. Consumer products organisations can enhance their enterprises by implementing competitive strategies to improve business performance and boost sales.

9. LIMITATIONS AND FUTURE DIRECTIONS

This study has some acknowledged shortcomings. Nonetheless, it is posited that several of them may function as significant precursors for further study endeavours. The analysis was limited to consumer goods companies registered on the Nigerian Stock Exchange; exploring various sector segments among the listed companies could provide further insights. The findings and consequences of this paper are confined to Nigeria, with a primary emphasis on consumer products companies, perhaps restricting the generalisability of the results. Consequently, the cross-sectional design of the study inhibits the author from asserting robust causal relationships. The research could be augmented by analogous studies performed in large corporations or publicly traded entities in Nigeria or other nations. The sample size can be increased by incorporating additional respondents using new data collection methods to enhance generalisability and reliability. However, the limitations of this research can be identified as gaps for further investigation, and it is advisable to conduct additional studies across diverse samples, locations, and countries.

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Declaration of AI

The author declares that AI-assisted tools were used solely to improve the linguistic quality, grammar, readability, formatting consistency, and editorial presentation of the manuscript. AI-assisted tools were employed during the preparation of the abstract, introduction, literature review, methodology, discussion, conclusion, and reference formatting to enhance language clarity, improve sentence structure, ensure consistency of academic expression, and assist with editorial refinement. No AI tools were used to generate research data, perform statistical analyses, formulate research findings, interpret results, or develop the scientific conclusions of this study. The author confirms that the use of AI-assisted tools complies with the ethical standards of his institution and the policies of *Modern Management Review*. The author carefully reviewed, verified, and edited all AI-assisted outputs and accepts full responsibility for the accuracy, originality, integrity, and final content of this manuscript.

Author Contributions

Author Contributions: Conceptualization: T. O. O.; introduction: T. O. O.; literature review: T. O. O.; identification of research gap: T. O. O.; theoretical framework: T. O. O.; methodology: T. O. O.; data collection: T. O. O.; formal analysis: T. O. O.; interpretation of findings: T. O. O.; writing – original draft preparation: T. O. O.; writing – review and editing: T. O. O.; visualization: T. O. O.; supervision: T. O. O.; project administration: T. O. O.; conclusion and recommendations: T. O. O.; references: T. O. O.

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ANALYSIS OF THE IMPACT OF ENTREPRENEURIAL INITIATIVES ON SUSTAINABLE DEVELOPMENT IN ALGERIA

The study aims to examine the impact of entrepreneurial initiative on sustainable development in Algeria over the period 2011–2025. It adopts a descriptive-analytical approach combined with econometric modeling to estimate the effect of both the growth rate of newly established start-ups and the growth rate of newly established micro-enterprises on GDP per capita. The findings reveal a principal result, namely the existence of a statistically significant and positive relationship between the growth rate of micro-enterprise creation and GDP per capita in Algeria during the study period. Specifically, a 1% increase in the growth rate of newly established micro-enterprises leads to a 4.24% increase in GDP, reflecting the strong multiplier effect of micro-enterprises in supporting economic growth, improving individual income, and strengthening the economic and social dimensions of sustainable development. In contrast, the impact of start-ups did not exhibit stable econometric significance throughout the study period due to the limited readiness of their supporting ecosystem in terms of venture capital financing, technological infrastructure, and the regulatory framework, which necessitated their exclusion from the optimal model.

Keywords: entrepreneurship, sustainable development, economic growth, stepwise model.

1. INTRODUCTION

Community entrepreneurship has become a crucial strategic choice in the face of rapid economic transformations and complex development challenges. Most research confirms that entrepreneurship has been, and remains, a fundamental pillar of both developed and developing economies. Indeed, it constitutes an effective mechanism for wealth and value creation, not only by stimulating the economic cycle but also by providing innovative solutions to various economic, social, technological, and cultural problems. The importance of entrepreneurship is amplified by resource scarcity and the depletion of many

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traditional energy sources. Economic growth no longer depends solely on the availability of natural resources but is now linked to the ability to utilize knowledge and innovation and to transform ideas into productive projects that reconcile economic profitability with social responsibility.

- Furthermore, entrepreneurial initiatives across all segments of society stand out as a crucial pillar for building sustainable development pathways globally, particularly among educated and trained youth. This population represents a strategic reserve of skilled human capital, capable of assimilating knowledge and technological transformations and engaging in new forms of entrepreneurial thinking based on creativity and innovation. The essential role of educational and training institutions in this process is undeniable. They can cultivate a culture of innovative thinking, thereby fostering the emergence of entrepreneurial initiatives capable of meeting the multiple demands of sustainable development.
- Sustainable development constitutes a comprehensive framework aimed at reconciling the imperatives of economic growth with ensuring social justice and preserving environmental resources for future generations. This approach requires moving beyond short-term development models to adopt more rational and sustainable modes of production and consumption. Entrepreneurial initiatives based on innovation and responsibility are among the most important mechanisms for realizing the principles of sustainable development by creating jobs, promoting social inclusion, and developing environmentally sound economic solutions. Furthermore, entrepreneurial initiatives undertaken by students and recent graduates of higher education and scientific research institutions represent a fundamental pillar of this approach, as they are based on knowledge, research, and creativity – essential elements for building genuine sustainable development.
- Economic development is one of the fundamental foundations for achieving sustainable development, given its role in enhancing productive capacities, expanding employment opportunities, and improving income and living levels. In this context, per capita GDP gains analytical importance as an approximate indicator of average economic performance and available resources per capita, allowing us to discern one of the paths through which economic dynamism can be reflected in social well-being. A rise in this indicator, when combined with expanded employment opportunities and improved income distribution, may contribute to shifts in consumption patterns, living standards, and social integration. From this perspective, analyzing the relationship between entrepreneurial activity and economic performance provides a deeper understanding of the channels that can support social transformation and enhance the development process. Accordingly, this study relies on per capita GDP to measure the economic dimension of development and explore the extent to which the development of entrepreneurial activity is linked to development dynamism in Algeria, without reducing the concept of sustainable development to this indicator alone.
- In the Algerian context, the issue of activating entrepreneurship and sustainable development has garnered the attention of successive governments, as it constitutes a strategic challenge, particularly in light of the structural challenges facing the national economy, notably its dependence on natural resource rents, the high youth unemployment rate, and the urgent need to diversify the economic fabric. These factors have led to a growing commitment from the State to reorient public policies

aimed at encouraging entrepreneurship. Stimulating entrepreneurship is inextricably linked to the need to strengthen the legislative and regulatory framework to guarantee clear rules, stable laws, and simplified administrative procedures. These conditions are essential to create an environment conducive to initiative and investment, an environment that fosters innovation and thus contributes to the dynamism of the national institutional fabric.

- However, this trend raises fundamental questions about the capacity of entrepreneurial initiatives, within the existing legislative and institutional framework, to generate a lasting impact on development, beyond their temporary contribution to business creation or unemployment reduction.

1.1. Study problem

The extent, to which these initiatives influence economic growth rates and their sustainability, as well as their capacity to simultaneously integrate economic, social, and environmental dimensions, remains a subject of academic debate, particularly in an economy striving to diversify its resources and reduce its dependence on traditional sources. From this observation stems the central problem of this study, which can be formulated by the following fundamental question:

What is the impact of entrepreneurial initiatives on sustainable development in Algeria during the period 2011-2025?

To explore this overarching question and derive logical, evidence-based conclusions, the following sub-questions are asked:

- How do intellectual contributions explain the economic dynamism of entrepreneurial initiatives?
- To what extent do the economic, social, and environmental dimensions of sustainable development rely on entrepreneurial thinking?
- To what extent have entrepreneurial initiatives in Algeria taken into account the environmental dimension of sustainable development during the period studied?
- What is the nature of the relationship between the growth index of the institutional fabric in Algeria and the economic growth index over the period 2011-2025?

1.2. Background and importance of the study

The background of any study is the main part of any scientific research. It explains to the reader the context and significance of the research study. It aims to provide a comprehensive understanding of the topic, provide an overview of previous related research, and identify knowledge gaps that the research seeks to fill. Moreover, the background helps highlight the importance of the current research and justify the need for it.

1.2.1. Study objectives

This study mainly aims to examine the impact of entrepreneurial initiative on sustainable development in Algeria over the period 2011-2025. The specific objectives are as follows:

- To contribute to the scientific literature by providing an in-depth analysis of the role of entrepreneurship in supporting sustainable development.
- To analyze the role of entrepreneurship in balancing the economic, social, and environmental dimensions of sustainable development.

- To examine the nature of the relationship between the development of the institutional framework and economic growth indicators in Algeria during the study period.
- To assess the extent to which entrepreneurship in Algeria aligns with national sustainable development goals.
- To highlight the impact of entrepreneurial thinking on the various dimensions of sustainable development, particularly the environmental dimension, which has been less studied to date.
- Conceptual and methodological distinction between economic growth and sustainable development by assessing the extent to which approved standard economic indicators can measure the impact of the contracting initiative in Algeria during the period 2011-2025, and determining the limits of generalizing its results to the social and environmental dimensions of sustainable development.
- Testing the consistency of theoretical foundations with applied measurement, ensuring that the estimated relationship between business establishment growth and per capita GDP is interpreted as a relationship with economic growth, without automatically equating it with the achievement of sustainable development in its integrated dimensions.
- To measure the impact of entrepreneurship on achieving sustainable development in Algeria over the period 2011-2025.

1.2.2. Importance of the study

This study is important because it addresses one of the major strategic issues influencing the performance of developed and developing economies. It highlights the measurement of the impact of entrepreneurial initiatives on sustainable development in Algeria over the period 2011-2025.

This analysis is part of an approach aimed at understanding the role of entrepreneurial initiatives in balancing the economic, social, and environmental dimensions of sustainable development.

Furthermore, the study examines the nature of the relationship between the development of the institutional framework and economic growth in Algeria, focusing on the extent to which these initiatives align with national sustainable development goals.

The importance of this study is deepened by its attempt to link the theoretical foundations of the entrepreneurial initiative with the requirements for empirically verifying its contribution to Algeria's development process, while taking into account the distinction between economic growth as one of the fundamental inputs to development and sustainable development as a multidimensional process of structural and societal transformation. Theoretically, the study allows for a reconsideration of the assumption that the growth of contracting initiatives necessarily leads to the achievement of sustainable development, by examining the nature of the relationship between the development of contracting activity and economic performance indicators.

The study also addresses the impact of entrepreneurial thinking on the economic, social, and environmental dimensions, emphasizing the importance of the environmental dimension, often neglected in previous studies. From this perspective, the study contributes to scientific research by analyzing the growing role of entrepreneurial initiatives in achieving sustainable development goals in Algeria.

Results: The results of this study will inform Algerian companies about how to deal with econometric modeling to estimate the effect of both the growth rate of newly established start-ups and the growth rate of newly established micro-enterprises on GDP per capita. The findings reveal a principal result, namely the existence of a statistically significant and positive relationship between the growth rate of micro-enterprise creation and GDP per capita in Algeria during the study period.

1.3. Study questions and hypotheses

To underscore the importance of our current research, this study attempts to answer the following question: What is the impact of entrepreneurial initiatives on sustainable development in Algeria during the period 2011-2025?

Based on the study's problem, its main question, and its specific objectives, the following sub-questions were formulated:

- How do intellectual contributions explain the economic dynamism of entrepreneurial initiatives?
- To what extent do the economic, social, and environmental dimensions of sustainable development rely on entrepreneurial thinking?
- To what extent does the contribution of the enterprise initiative in Algeria go beyond stimulating economic growth to lead to structural social transformations that enhance the comprehensiveness and sustainability of development during the period 2011-2025?
- To what extent have entrepreneurial initiatives in Algeria taken into account the environmental dimension of sustainable development during the period studied?
- What is the nature of the relationship between the growth index of the institutional fabric in Algeria and the economic growth index over the period 2011-2025?

Accordingly, based on the study's questions and model, the following main hypotheses were formulated, which will be tested and from which conclusions and recommendations will be drawn, as follows:

- The first main hypothesis: “Most academic work posits that the economic dynamism of entrepreneurial initiatives constitutes a major driver of innovation, increased productivity, and improved economic efficiency, which has a positive impact on medium- and long-term economic growth”.
- The second main hypothesis: “The economic, social, and environmental dimensions of sustainable development rely, to varying degrees, on entrepreneurial thinking. Its most significant impact is evident in the economic dimension, followed by the social dimension, while its impact on the environmental dimension remains relatively limited”.
- The third main hypothesis: “The positive impact of an enterprise initiative on economic growth in Algeria is not necessarily translated into sustainable social transformations unless it is coupled with its ability to generate decent job opportunities and improve income distribution. This requires a standard distinction between its impact on per capita GDP and its social impact”.
- The fourth main hypothesis: “Algeria is interested in entrepreneurial initiatives within the framework of its multidimensional development policy, particularly for the period 2011-2025”.

- The Fifth main hypothesis: "We hypothesize the existence of a statistically significant relationship between the index of growth of the institutional fabric in Algeria and the economic growth index for the period 2011-2025".

1.4. Study methology

To enrich the scientific aspects of the study, we used a descriptive and analytical approach. Using this method, we described all the theoretical concepts related to entrepreneurship and sustainable development and analyzed their relationship, particularly in developing countries, and more specifically in Algeria, by presenting a practical experience of supporting the creation of micro-enterprises and emerging businesses through the adopted strategy of support, guidance, and financing.

1.5. Study model

H1: Entrepreneurial initiative has a direct and positive effect on sustainable development.

H2: Entrepreneurial Ecosystem affects sustainable development indirectly through increasing the rate of establishment of start-ups and micro-enterprises (the mediating variable).

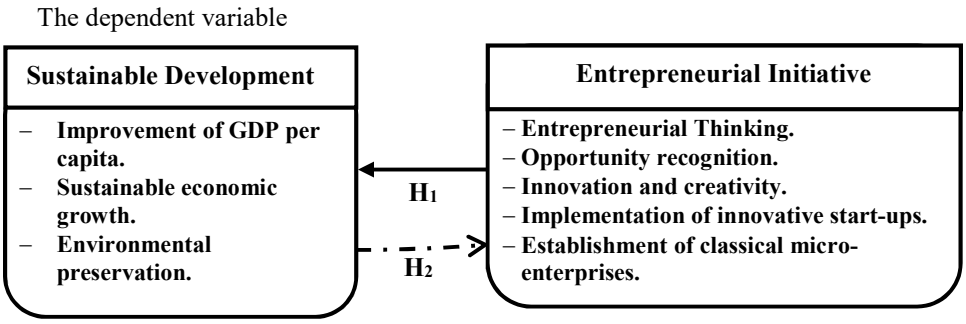


Figure 1. scheme of the study model

Source: prepared by researchers.

1.6. Limitations of the study

- **Human Limits:** The study sample was limited to entrepreneurs who are holders of ideas and projects and who have established their start-ups and micro-enterprises in Algeria. This category was selected in alignment with the national strategy aimed at strengthening and developing the entrepreneurial ecosystem responsible for wealth creation during the period 2011-2025. This strategic orientation is consistent with the Algerian state's broader initiative to foster a generation of competent entrepreneurs capable of actively contributing to economic development.
  The individuals within this sample represent qualified and trained human capital in the field of entrepreneurship. They are characterized by a set of distinctive individual competencies and skills related to entrepreneurial management and administration, particularly in the areas of strategic planning and the effective management of financial and human resources. Accordingly, these capabilities enable them to

efficiently mobilize and transform available resources within an economic context oriented toward value creation and sustainable wealth generation.

- **Time Limits:** This study was conducted during the period from 2011 to 2025, a period that allows analyzing the development of the contracting initiative in Algeria in the context of the transformations witnessed in economic policies, investment support programs, and diversification of productive activity. The importance of this timeframe stems from its connection to efforts to establish a more diversified growth model, reduce dependence on hydrocarbons, and enhance the contribution of contracting initiatives, particularly start-ups and micro-enterprises, to creating added value and expanding the national production base. From this perspective, the study not only assesses the relationship between the development of business creation and per capita GDP, but also considers the need to distinguish between the impact of economic policies on economic growth and the extent to which their effects extend to the social and environmental transformations associated with sustainable development. Accordingly, the period studied represents an analytical framework for assessing the contribution of enterprise dynamism to Algerian economic performance, while defining the limits of conclusions allowed by the approved quantitative indicators, without assuming that the improvement of economic indicators necessarily reflects the achievement of sustainable development in its integrated dimensions.
- **Spatial Limits:** This study included a sample of entrepreneurs from various regions of Algeria, encompassing both major cities and rural areas with notable entrepreneurial activity. The sample was selected to ensure a diverse representation of the national economic fabric, reflecting the variations in opportunities and challenges across different geographic contexts. This spatial scope also allows for the examination of the impact of development policies on small and emerging enterprises throughout the country. Thus, the geographic framework provides a solid basis for analyzing the results and identifying general trends in entrepreneurship at the national level.
- **Scientific Limits:** The current study focused on entrepreneurs and business founders in Algeria, particularly those who established start-ups or micro-enterprises. It examined their entrepreneurial skills, management practices, and their ability to mobilize and utilize financial and human resources effectively, as well as the role of strategic planning and organizational competencies in fostering business growth and wealth creation. The study also relied on statistical data and employed specialized software for measurement and estimation, in addition to the Stepwise model approach, to analyze shocks generated by explanatory indicators and to assess the effects of various variables with precision, thereby ensuring the reliability of the results and conclusions within the Algerian context.

2. THEORETICAL FRAMEWORK OF THE STUDY

2.1. Literature review

The relationship between entrepreneurial initiative and economic development has been a topic of significant interest for many economists throughout history. Neoclassical thought, in particular, served as a starting point for understanding the connection between economic growth and entrepreneurial activity, with “Joseph Alois Schumpeter” providing key contributions in this regard. Schumpeter argued that economic development does not

solely arise from the accumulation of capital or the increase of labor, but primarily depends on the ability of the economic environment to foster innovation and creativity. In his view, economic development is a dynamic process characterized by fluctuations between tradition and innovation. From this perspective, narrowing the gap between tradition and innovation can be achieved by enhancing an environment that is marked by creativity and entrepreneurial spirit. Thus, economic growth accelerates through entrepreneurial initiative, which acts as a driving force behind economic transformation.

In this context, the theoretical approach to the relationship between entrepreneurship and sustainable development requires distinguishing between the concept of economic development as a fundamental input for improving individuals' living standards, enhancing their productive capacities, and accumulating their wealth, and the concept of sustainable development as a more comprehensive framework that goes beyond quantitative indicators of growth, such as gross domestic product and per capita share, to include the structural, institutional, social, cultural, political, and behavioral transformations occurring in society. This vision finds its intellectual roots in the contributions of François Perrault, who distinguished between economic growth and development, believing that the latter is not reduced to the quantitative increase in production, but rather involves transformations in economic and social structures, power relations, and decision-making centers. This vision also intersects with Albert Hirschman's theses on unbalanced development, which start from the fact that sectoral imbalances and disparities in the pace of investment may lead, through mechanisms of interconnection and integration between economic activities, to creating new opportunities and stimulating the dynamics of structural transformation, as well as Paul Rosenstein-Rodan's contributions on Balanced growth, which emphasizes the importance of integrated investments and coordination between sectors to reduce development bottlenecks and expand the market. Based on this intellectual background, the enterprise initiative can be viewed as a mechanism for activating economic transformations, by mobilizing resources, creating productive activities, creating job opportunities, and spreading innovation, which contributes to raising income and improving the material well-being of individuals. However, the development impact of this initiative is not achieved automatically or simply by increasing growth rates. Rather, it depends on the extent to which public institutions and policies can transform economic gains into more comprehensive and just structural, social, and cultural transformations, taking into account environmental requirements and the rights of future generations. Accordingly, the entrepreneurial initiative represents one of the possible approaches to achieving sustainable development, not as an economic goal in itself, but rather as a motivating force for an integrated development path in which the economic, social and environmental dimensions interact within an institutional framework that ensures the sustainability of results and the distribution of their benefits to various segments of society.

Schumpeter's view fundamentally differs from that of classical economics, which posited that production depends on two essential factors: capital and labor. “Adam Smith”, in particular, emphasized that economic activity relies on the bourgeois individual who combines these two elements to achieve development. In contrast, "Schumpeter" contended that growth does not necessarily require the traditional bourgeois as its main driver; instead, it can be driven by the entrepreneur, an individual capable of thinking in innovative and unconventional ways. This entrepreneur creates new opportunities in the market, stimulates demand for goods and services, and thus contributes to the movement of the economic cycle, ultimately generating sustainable development.

As economic thought evolved in the late twentieth century, new ideas regarding endogenous growth emerged. One of the most prominent thinkers on this subject was Robert “Romer”. In his theory of endogenous growth, "Romer" emphasized that knowledge is a fundamental driver of economic growth, arguing that the skills acquired through practical experience and learning by doing are vital elements in fostering innovation and creativity. In this context, entrepreneurial initiative becomes a key dimension in enhancing productive capacities, improving the economy's ability to adapt to ongoing changes.

In contemporary thought, “Joseph Stiglitz” has added a new layer to understanding the relationship between entrepreneurial initiative and sustainable development. In his analysis, "Stiglitz" argued that entrepreneurial activity contributes not only to economic growth but also to societal welfare. According to “Stiglitz”, entrepreneurship significantly enhances the equitable distribution of resources and opportunities, thereby supporting sustainable growth. In this context, “Stiglitz” emphasized the importance of improving social welfare by strengthening the foundations of sustainable development, which can be achieved through encouraging economic activities that create jobs and contribute to improved living standards. This, in turn, can be measured by per capita real GDP.

Therefore, entrepreneurial initiative is not only an essential component of traditional economic growth but also a driving force behind sustainable development, encompassing social, environmental, and economic dimensions.

Our study seeks to address the topic of entrepreneurial initiative and its impact on sustainable development in Algeria. This is undertaken by estimating the effect generated by the independent explanatory indicators within our econometric model on the sustainable development indicator, expressed as real GDP per capita over the period 2011-2025. In order to achieve the scientific objectives of our study, we will present a set of previous studies that have examined the research variables relevant to our analysis, as follows:

A study conducted in the United Kingdom titled “Promoting Sustainable Development: The Role of Entrepreneurship Education” 2013, authored by Fernando Lourenço Manchester Metropolitan University, UK and Oswald Jones and Dilani Jayawarna University of Liverpool, UK.

This study examines a novel entrepreneurial approach to education for sustainable development, addressing concerns about the potential negative impact of a profit-oriented mindset in business schools on its effectiveness. Using the theory of planned behaviour and data from 257 young entrepreneurs, structural equation modeling tests the relationship between education for sustainable development, profit orientation, and learning intentions. The results show that the perception of the benefits of learning strongly reinforces entrepreneurs' intention to apply their knowledge. While a profit-oriented mindset negatively affects the perception of these benefits, it does not compromise the learning process itself. These findings have implications for research, public policy, and entrepreneurship education practices.

The second previous study is titled “Fostering Sustainable Development and Entrepreneurship: The New Role of the University” 2017, authored by Cristina Mititelu, and Gloria Fiorani and Irene Litardi from University of Rome “Tor Vergata” 2 Columbia St, Rome, Italy.

The study examines sustainable development as a global goal and explores the evolving role of universities in promoting it. It focuses on the School of Economics’ proactive education model, highlighting how student engagement fosters bottom-up social entrepreneurship. The research includes a descriptive analysis of innovative lab modules

and a case study of the UniRecycling waste management project, detailing objectives, stakeholders, activities, and outcomes. Findings show that the School of Economics, alongside partner institutions, effectively supports practice-oriented workshops that enhance knowledge, skills, and self-development. The study emphasizes that a dynamic, bottom-up learning model can empower students to develop social and environmental entrepreneurial projects and strengthen local networks, contributing to responsible and sustainable entrepreneurial development.

The third study is titled "Sustainable Development: From Responsibility to Entrepreneurship" 2012, authored by Rosa Maria Fischer and Graziella Comini.

This study focuses on the rise of social entrepreneurship and socio-environmental business as part of the broader agenda of multidimensional sustainable development. It examines the theoretical and empirical links between ongoing development challenges and the emergence of enterprises that generate both economic and social value. The research highlights how academia, through institutions like CEATS since the mid-1990s, has supported companies, public agencies, and civil society in developing sustainable and socially responsible practices. In Brazil, corporate social initiatives have shifted from traditional philanthropy to systemic sustainability strategies that integrate innovation and long-term social and environmental impact. Key activities emphasize enhancing both corporate and social capital within ecosystems, while promoting balanced outcomes in economic, social, and environmental dimensions. The study underscores the importance of cross-sector strategic alliances and improved management of civil society organizations in supporting sustainable entrepreneurship. The main finding is that embracing multidimensional sustainability transforms corporate responsibility into a driver of social innovation and inclusive development.

The fourth study is titled "The University's Role in Sustainable Development: Activating Entrepreneurial Scholars as Agents of Change" 2019, authored by Ingrid Wakkee and Peter van der Sijde, Christiaan Vaupell, Karminder Ghuman.

This study examines how entrepreneurial universities can act as agents of sustainable development, particularly in developing countries, where their role has been largely overlooked. Using qualitative methods and institutional perspectives on sustainable change, it shows that local challenges such as poverty and pollution can motivate universities to adopt a sustainability vision that drives institutional transformation. Key factors include campus leadership, holistic teaching and research programs, and student engagement, which can generate meaningful short-term local effects. However, limitations of small-scale campuses restrict broader sustainable impact, positioning them instead as incubation spaces for innovative practices that can later be scaled. The study emphasizes that entrepreneurial universities promote sustainable change through education and outreach rather than traditional commercialization and highlights the value – and risks – of testing new sustainability concepts in separate spaces before applying them more widely.

The fifth previous study, entitled "The Relationship between Innovation and Sustainable Development: A Standard Study of Small and Medium Enterprises in Algeria" (2023), prepared by researchers Sidi Mohamed Boumediene Khatib and Bouazza El Amin Zemri, is one of the studies directly related to the research problem; It aimed to measure the impact of innovation on the economic, social and environmental dimensions of sustainable development in Algeria during the period 2010-2021, using the linear regression model and the least squares method. It found a statistically significant positive impact of innovation on the economic dimension, compared to a weak statistical correlation with the social dimension, and the absence of a statistical relationship with the

environmental dimension. The importance of these findings lies in their confirmation that stimulating economic performance does not necessarily mean achieving sustainable development in its integrated dimensions. This supports the methodological distinction made in the current study between the impact of an enterprise initiative on per capita GDP and its potential contribution to social and environmental transformations, while taking into account the limits of economic indicators used to infer sustainable development.

2.2. Theoretical framework of entrepreneurial initiatives

The adoption of entrepreneurship, both in theory and in practice, has undoubtedly become one of the main drivers of sustainable development in all types of countries. This is explained by the characteristics of entrepreneurial projects and institutions, which allow them to contribute effectively to economic growth, increase investment, stimulate innovation, and restructure the economic fabric. Despite these strengths, society still suffers from social problems and a lack of essential services, and markets are experiencing declining performance in many sectors. The state alone cannot address all these fundamental social and human challenges. This suggests to members of these societies the need to take the initiative to contribute to resolving their problems and meeting their needs in a creative and sustainable way, by encouraging the launch of entrepreneurial initiatives by young, creative, and innovative entrepreneurs with an effective entrepreneurial mindset and practice.

2.2.1. The concept of entrepreneurship

To return to the first intellectual contributions that introduced the term "entrepreneurship" into economic literature, we must look to the beginning of the 18th century, and more specifically to the work of the Irish banker Richard Cantillon, entitled: An Essay on the Nature of Trade in General. In this work, the author distinguishes between landowners, entrepreneurs, and workers within the economic system and emphasizes the importance of the entrepreneur in economic development. He described the entrepreneur as an individual who demonstrates the will to create a new project or institution capable of generating added value for the economic and social spheres. This contrasted with the classical approach to economic analysis, which asserted that the growth of productive sectors to the optimal level of production and full employment constituted the foundation of economic growth, with labor and capital being the pillars of productivity. Ideas emerged suggesting the existence of alternative production models capable of satisfying new needs, even in the absence of capital and labor (Chell, 2007). According to this perspective, some successful institutions possess ideas that can be applied in practice, but their implementation involves a certain degree of risk, in addition to the lack of financial resources to launch the projects and the associated investments. This led to the development of entrepreneurship as a distinct approach to development.

From the 19th century onward, the concept of entrepreneurship attracted the interest of many economists. "Joseph Alois Schumpeter", with his original ideas on entrepreneurship and economic growth, represented a neoclassical approach to the concepts of development. His theory emphasized that production is not limited to the capitalist bourgeoisie employing labor in workshops to transform raw materials into consumer goods. He argued that it is the idea, and its uniqueness, that creates value in any economy.

- Launching a new product or improving an existing one in an innovative and creative way to generate wealth,
- Introducing a new production method,

- Securing new sources of raw materials,
- Opening new markets,
- Adopting a new method of planning and organizing production sectors.

The term "entrepreneurship" has become widespread, and its meaning has evolved to become one of the theoretical concepts that have generated considerable interest among economists. Henri Fayol, in a 1999 study, defines it as "a culture specific to an investment enterprise that allows it to create economic and social wealth, characterized by a high degree of uncertainty and the presence of constant risk in its management".

Another well-known definition of entrepreneurship is that of Karadeniz and al (2009), who conceives of it as: "Any attempt to create a new business or to develop an existing business activity by an individual, a team of individuals, or an existing company" (Karadeniz, Esra, Ozlem, 2009). Therefore, he defines an entrepreneur as "a person specializing in taking responsibility and making decisions that affect the location, form, and use of goods, resources, or institutions". Entrepreneurship can also be defined, according to Pesqueux (2014), as "an activity of discovering, evaluating, and exploiting opportunities, with the aim of introducing new goods and services, as well as new organizational structures, markets, processes, or resources, by means that, where applicable, did not previously exist (Schlichte, 2025)".

There are many fairly similar definitions of entrepreneurship, reflecting the growing interest in this concept and its connection to numerous terms associated with it in entrepreneurial practice, such as entrepreneurial culture and entrepreneurship. We will define the conceptual content of each term individually below.

2.2.2. The concept of entrepreneurial initiatives

The term "entrepreneurial initiative" is used to refer to what is also called "entrepreneurial action". Entrepreneurship can be defined as "any activity undertaken by an entrepreneur in the context of creating, managing, and developing a new business, aiming to generate wealth and achieve the objectives of the business, targeted consumer segments, or even those of society as a whole. The entrepreneurial initiative must be a unique, ethical, and attractive venture, allowing the entrepreneur to explore the mechanisms for realizing their innovative ideas, while securing the necessary financing and managing the risks inherent in entrepreneurial activity within a small business (Usman, Kess-Momoh, Ibeh, Elufioye, Ilojianya, Oyeyemi, 2024)".

Entrepreneurial action is also defined as "the behaviour and activity resulting from a mindset that directs a person's attention, experience, and conduct toward a specific goal, path, or action" (Frese, Gielnik, 2023). "Intention is at the root of the motivational factors that influence an individual's behaviour in terms of innovation or creativity. It is simply a matter of intelligently and ethically planned individual efforts that enable the creation of value for society and the economy as a whole" (Lee, Kim, Ivan, 2024).

The enterprise initiative will be one of the pivotal mechanisms in stimulating economic dynamism and bringing about the structural transformations on which the development process is based, given its role in mobilizing resources, promoting innovation, creating job opportunities, and expanding the productive base of the economy. Based on François Perrault's development vision, which distinguishes between mere quantitative expansion in production and the structural transformation accompanying development, entrepreneurial activity can be viewed as a driving force for renewing the economic fabric and stimulating the spread of the effects of growth between sectors and economic actors. This relationship is particularly important in explaining the link between entrepreneurship

and sustainable development. Increasing productive activity and improving employment and income generation opportunities can contribute to raising the average per capita GDP, enhancing economic potential to improve living standards and social well-being. Accordingly, adopting this indicator in the study allows for an analysis of one of the economic paths through which the effects of entrepreneurial initiatives are transmitted to the development sector, while emphasizing that the impact of these effects on social and environmental sustainability remains linked to how the fruits of growth are distributed, resource management, and the mechanisms for transforming economic gains into sustainable improvements in societal well-being.

2.2.3. Approaches to entrepreneurial initiatives

Entrepreneurial initiative is a central concept in contemporary economic and administrative studies, given its crucial role in economic development, job creation, and the promotion of innovation. Approaches to studying entrepreneurial initiative have diversified, reflecting the variety of theoretical perspectives and analytical methods. Some approaches address it from an individual perspective, focusing on the characteristics and motivations of the entrepreneur, while others examine the organizational, environmental, and institutional dimensions that shape the emergence and sustainability of initiatives. This diversity of approaches reflects the nature and complexity of the entrepreneurial phenomenon and requires a comprehensive approach to understand its various mechanisms and dimensions. Approaches to entrepreneurial initiative can be grouped into three categories:

2.2.3.1. Anti-entrepreneurial factors

These represent all the personal and environmental factors that foster the development of predispositions in an individual. Researchers have observed that students whose parents are self-employed exhibit higher entrepreneurial potential than others.

2.2.3.2. Embodying entrepreneurial potential and skills in a project

This process unfolds under the influence of motivational factors, including positive and disruptive factors. The stronger the motivational factors, the more individuals are incentivized to create a business. Individuals with greater entrepreneurial potential and skills require fewer motivational factors.

2.2.4. Entrepreneurial behaviour a pillar of entrepreneurial initiative

Adopting entrepreneurial behaviour has become imperative in the face of changes in the international business environment. Organizations that fail to instill this behaviour in their employees cannot survive or thrive, as they will struggle to leverage their knowledge resources.

Entrepreneurship primarily refers to the behaviours an individual within an organization should adopt to fulfill their responsibilities in an organized and efficient manner. This is achieved by valuing initiative, creativity, and innovation, as well as cultivating a desire to continuously improve one's environment. The responsibility for ensuring one's own survival as an individual within a group remains a top priority. This involves managing all potential risks, including those related to work-related problems that may arise in production activities or those related to management and administration. Workplace accidents are currently on the rise due to the increasing responsibilities of organizations in their strategic activities. Therefore, it is essential to foster an

entrepreneurial spirit to mitigate the difficulties that hinder efficiency and performance at work (Yatribi, Giraud, 2017).

Entrepreneurial behaviour or action is considered the product of an entrepreneurial spirit. The very creation of an organization requires individuals capable of responding positively to risks and managing them with a focus on safety. This is achieved by proactively developing intelligent solutions to prevent all professional problems related to the individual, both within and outside the organization. Consequently, Hélène Verin argues that the evolution of economic analysis, including its conceptual framework, has enabled the emergence of a new type of social being: one who acts rationally according to their objectives and thus becomes an entrepreneur.

2.2.5. Determinants of entrepreneurial initiative

Numerous factors determine the propensity of an individual or a company to undertake entrepreneurial activities. These factors are generally interdependent and mutually reinforcing, making it impossible to isolate them. We will highlight the main factors influencing entrepreneurship below.

2.2.5.1. The general regulatory framework

The general regulatory framework influences the willingness to start a business. This framework encompasses many elements, including the time frame for starting business activities, understanding bankruptcy and insolvency laws that determine the survival, cessation of business, liquidation, or dissolution of a company, knowledge of administrative procedures, and other factors, within this framework, corruption.

2.2.5.2. Caracteristics of target markets forentrepreneurial activity

Market structure and its competitive characteristics influence the individual capabilities of entrepreneurs, particularly in terms of innovation and creativity, as well as their ability to undertake other entrepreneurial activities. Competition provides a greater incentive to invest in innovation and facilitates access to global export markets. Furthermore, it allows companies to develop their business lines based on data and developments in target markets, thereby increasing their productivity (Clercq, Voronov, 2011).

2.2.5.3. Research and development capability

Research and development (RandD) is a fundamental organizational function for any strategically oriented organization striving to achieve a strategic vision reflecting its desired future. Innovation and creativity stem from RandD, as well as from continuous monitoring in this area. A consistent and increasing investment in RandD within the entrepreneurial process enables businesses to identify, assimilate, and utilize new technologies, keep pace with current global technological trends, and strengthen their presence in local and even international markets.

2.2.5.4. Access to finance

Due to the limited or nonexistent collateral that startups can offer financial institutions, particularly banks, to secure financing, access to finance remains the primary obstacle entrepreneur’s face in realizing their innovative ideas, launching their businesses, and scaling up operations. According to 2019 international estimates, 70% of micro, small, and medium-sized enterprises (MSMEs) in emerging markets, including startups, lack access to finance. The financing gap for these businesses in the formal sector of developing

countries reached $5.2 trillion, and this gap rises to $8.1 trillion when informal sector businesses are included.

2.2.5.5. Business incubators

The existence of effective business incubators is essential for creating an environment conducive to the creation of new businesses and the transfer of technology. Business incubators offer financing, training, and technology transfer services, thereby stimulating potential growth in most economic sectors and providing access to a wide range of resources for business development. Business incubators are a vital tool for encouraging entrepreneurship, developing MSMEs, creating jobs, and ultimately improving the living standards of communities.

2.2.5.6. Human capital and skills accumulation

Human capital accumulation is one of the fundamental mechanisms by which the ability of an enterprise initiative to exceed the limits of achieving direct economic returns and contributing to societal development is determined. From the perspective of human capital theory, the impact of education, training and skills acquisition is not limited to raising the productivity of individuals, but rather extends to enhancing their ability to absorb knowledge, employ technology and innovation, and improve their efficiency in making decisions, solving problems and adapting to economic transformations. In this context, the ability of emerging, small and medium enterprises to continue and grow depends on the extent to which their owners and workers possess a cumulative balance of technical, administrative and organizational skills, including resource management, production, marketing and finance, which reduces management errors and enhances the efficiency of resource allocation. However, the developmental importance of human capital accumulation is not measured solely by its returns within an organization, but also by its ability to have extended societal impacts by improving individuals' employability, developing their professional skills, enhancing their opportunities for integration into economic activity, transferring knowledge between institutions, and expanding learning and qualification opportunities. Thus, an entrepreneurial initiative becomes a potential area for skill accumulation and human capacity development, provided that the job opportunities it provides are coupled with continuous training, on-the-job learning, and improved job quality, and that its impact is not limited to the creation of formal or temporary jobs. From a sustainable development perspective, this distinction requires separating the economic impact of an enterprise initiative, which can be estimated through production and income indicators, from its social impact, which requires independent indicators that reflect skills development, employment quality, opportunities for professional integration, and the extent to which different groups benefit from the fruits of economic activity. Therefore, human capital accumulation represents an important explanatory link for understanding the conditions under which a business initiative can transform from an economic value-generating activity into a mechanism supporting community development, without assuming this transformation occurs automatically or inferring it from economic indicators alone.

2.2.5.7. Sociocultural and individual caracteristics

Entrepreneurship is the product of a complex environment characterized by sociocultural values, economic conditions, customs, and laws. These differences are reflected in how businesses are managed and how contracts are negotiated and executed.

3. MOTIVATION AND CONDITIONS FOR SUCCESS OF ENTREPRENEURIAL INITIATIVES

Entrepreneurial initiatives are based on a set of motivations that encourage small and medium-sized enterprises (SMEs) to undertake them. These motivations define the characteristics and strengths that the entrepreneur and the environment in which they operate must possess. We will also discuss the main success factors of entrepreneurial initiatives.

3.1. Motivation for entrepreneurial initiatives

To achieve high efficiency in their entrepreneurial initiatives and generate the expected economic and social impacts, entrepreneurs are driven by a set of motivations that push them to embark on entrepreneurship and assume the associated risks. These motivations can be summarized below, although this list is not exhaustive:

3.1.1. Internal factors related to the entrepreneur

These factors concern the internal characteristics of entrepreneurs that encourage them to create their own businesses. They can be summarized as follows (Dean, McMullen, 2007):

- The desire to innovate,
- The desire for professional independence,
- A sense of dissatisfaction with the job held by potential entrepreneurs before embarking on entrepreneurship,
- The lack of jobs or skilled professions due to economic difficulties pushes entrepreneurs to seek innovative ways to generate income. This ambition to create jobs fosters a sense of satisfaction and confidence among entrepreneurs, motivating them to create new and significant businesses for themselves and their communities,
- The need for success and recognition. Many entrepreneurs are determined to create their businesses to gain the approval and recognition of their communities and public authorities. Having an independent and fulfilling business provides a sense of accomplishment and motivates them to develop new products that meet the needs of their customers and communities.

3.1.2. External factors related to the entrepreneurs environment

- Achieving higher profits.
- Availability of opportunities and resources: The availability of resources such as physical capital, human capital, raw materials, infrastructure, and facilities plays a significant role in motivating entrepreneurs.
- Personal fulfilment: Many entrepreneurs dare to take risks by creating new and sometimes challenging businesses, driven by a desire for personal fulfilment and development. It is the problems their communities face and the complex, deeply rooted challenges that stimulate innovation and growth among entrepreneurs.

3.2. Condition as for success of entrepreneurial initiative

The success of an entrepreneurial initiative rests on a set of fundamental elements that enable the entrepreneur to realize their innovative and creative ideas. It also requires the ability to analyze their environment and adapt to it according to their business objectives,

seizing opportunities and mitigating potential threats. We will present the most important of these conditions below:

3.2.1. Infrastructure

This involves providing adequate facilities, equipped with the necessary materials for entrepreneurial training, which is a prerequisite for implementing entrepreneurial practices.

3.2.2. Skilled and human resources

These resources must be able to use and implement advanced entrepreneurship training strategies and methods, and to effectively use information technologies to transform abstract ideas into tangible realities. – A supportive environment that fosters the implementation of the entrepreneurial initiative's programs, plans, and objectives. This environment derives its strength and excellence from the full awareness of community members at all levels, from the leaders and decision-makers of the entrepreneurial team to employees and stakeholders. This awareness fosters cooperation and unconditional support from everyone to ensure the success of this entrepreneurial initiative (Gibb, 1993).

– Respond to the significant challenges and pressures that the nature of the current environment exerts on this type of entrepreneurial practice and behaviour, and strive to adapt to them as much as possible.

4. INTELLECTUAL APPROACH THAT INTERPRETED THE RELATIONSHIP BETWEEN ENTREPRENEURIAL INITIATIVES AND SUSTAINABLE DEVELOPMENT

Sustainable development is one of the fundamental concepts that has emerged from contemporary economic, social, and environmental transformations. It aims to achieve a balance between the demands of economic growth, social justice, and environmental preservation, ensuring that the needs of the present are met without compromising the rights of future generations. Consequently, entrepreneurship has emerged as one of the effective mechanisms on which intellectual literature has increasingly focused, given its role in achieving the Sustainable Development Goals. Various intellectual approaches have sought to explain the theoretical relationship between sustainable development and entrepreneurship. Some schools of thought have viewed entrepreneurship as an engine of economic growth and job creation, while others have concentrated on its contribution to promoting social inclusion and the adoption of environmentally friendly innovations. This diversity of intellectual approaches reflects the integration of developmental and entrepreneurial dimensions within a comprehensive vision of sustainable development.

4.1. The concept of sustainable development

The concept of sustainable development refers to development that, in its implementation, aims to simultaneously ensure the integration and interdependence of its economic, social, and environmental dimensions, without compromising any of them. It also emphasizes the capacity to maintain and preserve the use of natural resources. Linguistically, the word “development” derives from the verb “to grow”, which means increase and abundance. The verb to sustainhas several meanings, including patience and perseverance, the term “sustainable development” (Pohoaţă, Diaconaşu, and Crupenschi, 2020) comes from the English expression “sustainable development”. The first definition reflects the principle of continuous development, while the second refers to the self-sustaining forces that ensure continuity. However, the first is more commonly used and

will be the one adopted in this study. We present below the main definitions of sustainable development.

The World Commission on Environment and Development defines it as “development that meets the basic needs of all, expands opportunities for society to realize its aspirations for a better life, and promotes values that encourage consumption patterns that respect the environmental potential to which society reasonably aspires” (Krautkramer, Jeffrey, 1985).

Among the definitions of sustainable development that garnered consensus among most countries at the United Nations Conference on Environment and Development (Earth Summit) is the one that describes it as "the need to realize the right to development in such a way that the developmental and environmental needs of present and future generations are met equally." The emphasis is, and remains, on the necessity of interdependence, highlighting the link between environmental protection and development, and the elimination of social problems, including poverty, unemployment, and other social hardships.

Sustainable development is also defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It aims for harmony and integration between the environment and development through three systems: a biological resource system, an economic system, and a social system” (Yildirim, Aslan, 2012). In other words, sustainable development is a societal process in which all groups and sectors must participate harmoniously.

Thus, a comprehensive operational definition of sustainable development can be proposed as a conscious and continuous societal process, guided by independent national will, aimed at creating structural transformations and inducing political, social, and economic changes that enable sustained growth in the capacities of the society concerned and a continuous improvement in the quality of life. This development must be based on a clearly defined, multidimensional, long-term vision and employ mechanisms and methods that improve the quality of life. This includes entrepreneurial practices, particularly social ones, as they address the unemployed, people living in poverty, and similar groups, thereby broadening participation in achieving harmonious and sustainable development.

Sustainable development can be defined procedurally, based on François Perrault's development vision, as a path of economic and structural transformation aimed at achieving cumulative and continuous growth in real output, reflected in improving the standard of living and the economic and social well-being of individuals. This concept is based on the premise that development is not limited to quantitative increases in production, but rather includes mental, social, and institutional transformations that enable sustainable growth and enhance its developmental impact.

4.2. Sustainable development goals

The Sustainable Development Goals (SDGs) are integrated and indivisible, universal in nature, and globally applicable. They take into account the realities, capacities, and development levels specific to each country and respect national policies and priorities. Indeed, each country faces specific challenges in its pursuit of sustainable development, requiring strategies, models, and tools tailored to its situation and national priorities. The general SDGs can be summarized as follows:

- Eradicate poverty in all its forms and at all levels.
- End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
- Ensure healthy lives and promote well-being for all at all ages.

- Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Eliminate discrimination against women and girls and strive for gender equality.
- Ensure access to modern, reliable, and sustainable energy for all. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

The Sustainable Development Goals (SDGs) do not stop there; they go further and encompass seventeen principles that commit all countries to making effective progress toward wealth-creating sustainable development (Glass, 2019).

4.3. Economic growth, a key driver of sustainable development

Economic growth is a fundamental theoretical and practical pillar of sustainable development. It provides the framework for societies to increase their productive capacity and improve income levels and social well-being. From an economic perspective, growth provides the financial resources needed to fund investments in infrastructure, education, health, and clean technologies – all essential elements for achieving the three dimensions of sustainable development: economic, social, and environmental. Growth also contributes to job creation and the reduction of poverty and unemployment, thereby promoting social justice and stability, and strengthening countries' capacity to adopt more effective environmental policies.

However, the relationship between economic growth and sustainable development is not linear, but depends on the nature and model of that growth. Unsustainable growth, based on the excessive exploitation of natural resources, can lead to environmental degradation and social imbalances that hinder the long-term sustainability of development. Therefore, achieving sustainable development requires the adoption of a comprehensive and sustainable growth model, based on the efficient use of resources, technological innovation, and good governance, ensuring that the needs of the present are met without compromising the ability of future generations to meet their own (El Cham, 2021).

Measuring the Impact of Entrepreneurial Initiatives on Sustainable Development in Algeria.

Most previous empirical studies have highlighted the impact of entrepreneurship on sustainable development, particularly the effect of the growth index of micro-enterprise and start-up creation on the economic growth index, considered a determinant of sustainable development in Algeria. This study therefore aims to measure this impact in one of the most important emerging economies in North Africa, namely the Algerian economic system. To do so, it will rely on indicators of the development of a diversified institutional fabric, in particular the growth of start-up creation and the micro-enterprise creation growth index, as independent explanatory indicators. The study will also consider the growth rates of Algeria's national GDP over the period 2011-2025 as a dependent variable, using annual time-series data and a technical measurement method.

5. DESCRIPTION OF THE ECONOMETRIC VARIABLES AND THE MODEL USED

To assess the relationship between the explanatory variables and the dependent variable in our econometric study, we will rely on statistical data relating to the econometric variables, as illustrated in the following table:

Table 1. Descriptive statistics for study variables

Statement	Indicator	symbol
The dependent variable in the standard study		
Per capita GDP is a comprehensive indicator for measuring average economic output per capita, and is calculated by dividing GDP by the total population, allowing an assessment of the development of economic performance and the level of production per capita over time. According to the United Nations Sustainable Development Goals Indicators Framework, this indicator is linked to Goal 8 on sustainable and inclusive economic growth. However, its significance remains primarily economic and is not sufficient to judge the fairness of income distribution, quality of employment, or environmental sustainability. Based on this, the study adopts this indicator as a dependent variable to measure the relationship between the enterprise initiative and economic growth in Algeria during the period 2011–2025 Distinguishing between improving economic performance and achieving sustainable development in its integrated sense, which requires independent indicators of social and environmental dimensions.	GDP growth rates	y_t
Independent variables within the standard study		
The growth index of emerging businesses is interpreted as the rate at which new, innovative companies are created each year. This index reflects the level of entrepreneurship and innovation in the economy and its ability to generate new economic activities. Its rise indicates an improvement in the environment for innovative entrepreneurship, support for investment in innovation, and the creation of quality job opportunities.	Startup Growth Index SCG Index	x_1
The growth index of micro-enterprise creation indicates the extent to which the number of new micro-enterprises created each year is developing. This index reflects the level of dynamism of economic activity, entrepreneurship, and investment in the economy. A rise in this index indicates an improvement in the business climate, the availability of financing opportunities, and an increase in job opportunities.	Micro-enterprise creation growth index M-ECG Index	x_2

Source: Prepared by researchers.

Assuming a linear relationship between the variables in the model, the standard model can be written as follows:

$$\boldsymbol{y_t = \beta_0 + \alpha_1 X_1 + \alpha_2 X_2 + \varepsilon_t} \quad (1)$$

5.1. Description of the standard study model

Our study aims to measure the impact of indicators of emerging business and micro-enterprise creation on GDP per capita in Algeria. In this context, it is preferable to identify the most important explanatory variables based on their impact and their ability to induce

variations in the dependent variable. Drawing on previous studies, we adopted a modern method for estimating the optimal model, known as the stepwise method. This method relies on the progressive elimination of insignificant explanatory variables, characterized by a relatively low coefficient of determination (R^2). In other words, it prioritizes the selection of high-quality independent explanatory variables with high significance and a large coefficient of determination (R^2), which reflects the strength of the correlation and the relationship between these variables and the dependent variable.

Table 2. Independent explanatory variables excluded from the analysis of the impact of start-up and micro-enterprise creation indices on the GDP per capita index in Algeria between 2011 and 2025

Excluded Variables[a]						
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	x1	.241b	1.685	.108	.391	.352
a. Dependent Variable: y_t						
b. Predictors in the Model: (Constant), x_2						

Source: Compiled by researchers based on program results EViews12.

According to Table 3, the second variable X_2, representing the micro-enterprise creation rate in Algeria, was selected as the explanatory variable in the ideal model to estimate the impact of entrepreneurial initiatives on sustainable development in Algeria between 2011 and 2025. This choice is justified by its high coefficient of determination ($R^2 = 0.883$), which explains the variations in the phenomenon studied. Indeed, the share of GDP per capita in Algeria is 88.3% based on the micro-enterprise creation rate, making it a significant variable at the 5% level. The following tables illustrate these results.

Table 3. Sommerai's model, which determines the strength of the correlation of the independent variable X_2, which has the greatest influence on the dependent variable Y_t

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.940	0.883	0.875	0.283186207731979

a. Predictors: (Constant), x_2

Source: Worked by consultants on the program results EViews12.

This optimal model for estimating the effect of the independent variable X_2 (Table 4) on the dependent variable Y_t was accepted, as evidenced by the highly significant results of Fisher's test at a significance level of 5%.

The applied standard study relied on two explanatory variables that reflect two complementary dimensions of the contracting initiative in Algeria; The X1 variable expresses the growth in the creation of emerging institutions mainly related to innovative contracting, while the X2 variable reflects the growth in the creation of small institutions that contribute to expanding the base of economic activity and meeting market and local needs. Both indicators fall within the conceptual concept of the enterprise initiative as

a mechanism for transforming economic opportunities into value- and wealth-producing activities, and promoting job creation and income accumulation.

Table 4. ANOVA Test Results – Significance of the Independent Explanatory Variable X_2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.170	1	6.170	103.731	0.000b
	Residual	1.048	15	0.057		
	Total	7.139	16			
a. Dependent Variable: y_t						
b. Predictors: (Constant), x_2						

Source: Prepared by researchers based on program outputs EViews12.

The two variables were subjected to statistical estimation and selection procedures to determine their explanatory contribution to the dependent variable, according to the model specifications and available data. In light of the results of gradual selection, the X2 variable was retained in the final model, which defines the scope of direct standard inference without meaning the absence of the economic importance of emerging enterprises. Accordingly, the results are interpreted within the limits of the estimated relationship, distinguishing between the conceptual comprehensiveness of the contracting initiative and the partial statistical representation allowed by the specifications of the final model.

Estimating the Standard Study Model

Using annual time-series data representing all explanatory variables in the model, after the progressive elimination phase described previously and with the help of EViews12 software, the following estimation results were obtained.

Table 5. Results of the long-term estimation of the effect of the independent explanatory variable X_2 on the dependent variable Y_t during the study, over the period 2011-2025

Coefficientsa						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.837	.502		47.895	.000
	x2	5.239	5.82	.964	9.255	.000
a. Dependent Variable: y_t						

Source: Compiled by researchers based on program results.

EViews12.

According to the results in table no. 06, which defines the estimated regression equation in this model, it can be written in the following form:

$$\mathbf{y_t = \beta_0 + \alpha_1 X_2 + \varepsilon_t} \quad (2)$$

where:

$\mathbf{Y_t}$: Dependent variable of the estimated model, representing GDP per capita for each year of the period 2011-2025.

0ß Value of the constant of the estimated model.
α1 : Significance of the independent explanatory variable X_2.
X_2 Second independent explanatory variable, representing the growth rate of new micro-enterprises for each year of the period 2011-2025.
εt Value of the residuals of the model.

Based on the estimation results presented in Table 6, the model can be written as follows:

$$\mathbf{y_t = 10.837 + 5.239X_2} \quad (3)$$

The estimation results indicate a significant long-term effect of the independent explanatory variable, represented by the growth rate of micro-enterprise creation in Algeria, over the period 2011-2025. For each one-unit increase in the independent explanatory variable X_2, the dependent variable Y_t increases by 5.239 units, reflecting a significant and positive effect in our study.

5.2. Statistical quality test of estimated model

Before accepting the results of this estimation for the economic interpretation of the effect of the independent explanatory variable X_2 on the dependent variable Y_t, it is essential to ensure that the estimated model is free from common statistical problems.

a. Autocorrelation Test of Errors:

The Breusch-Godfrey test is considered one of the best tests in this regard. The results of this test are summarized in the following table.

Table 6. Results of the Autocorrelation Test of the Estimation Residuals

Breusch-Godfrey Serial Correlation LM Test: Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	2.880119	Prob. F(2,15)	0.0607
Obs*R-squared	5.490016	Prob. Chi-Square(2)	0.0262

Source: Prepared by the researcher based on the outputs of the program.

EViews12.

According to the results in Table 6, the calculated Fisher's exact test value (F-statistic = 0.0607) is less than the critical value at the 5% significance level. Therefore, we accept the null hypothesis, meaning that there is no autocorrelation between the estimated residuals.

A. Testing the Hypothesis of Homogeneity of Error Variance:

To confirm the hypothesis of homogeneity of error variance, we use the Broch-Bagan-Godfrey test, as shown in Table 7.

Table 7. Broch-Bagan-Godfrey Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.168473	Prob. F(1,17)	0.6612
Obs*R-squared	0.177518	Prob. Chi-Square(1)	0.6719
Scaled explained SS	0.091550	Prob. Chi-Square(1)	0.7769

Source: Prepared by the researcher based on the outputs of the program.

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Referring to the results in Table 7, it is evident that the calculated value for Fisher's test is less than the tabulated value at a significance level of 5%. Therefore, we accept the null hypothesis, which indicates the consistency or homogeneity of the error limit variance of the estimated model.

C- Ramsey Reset Test:

This test is used to determine the suitability of the model, in terms of its functional form, for expressing the relationship between economic variables. The results of this test are as follows.

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Based on the results in Table 8, it is clear that the probability value of Fisher's test is greater than the 5% significance level. Therefore, the proposed functional model for expressing the relationship between the studied economic variables can be accepted.

D- Normality of Estimate Residues:

The Jarque-Bera test is used, where the null hypothesis indicates that the errors follow a normal distribution. The results of this test are shown in the following figure 2.

Table 8. Results of the Ramsey Reset Test

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: Y X2 C

	Value	df	Probability
t-statistic	1.097711	16	0.2794
F-statistic	1.207116	(1, 16)	0.2984
Likelihood ratio	1.392762	1	0.2407

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.072821	1	0.071629
Restricted SSR	1.021053	17	0.061052
Unrestricted SSR	0.954499	16	0.058819

Source: Prepared by the researcher based on the outputs of the program.

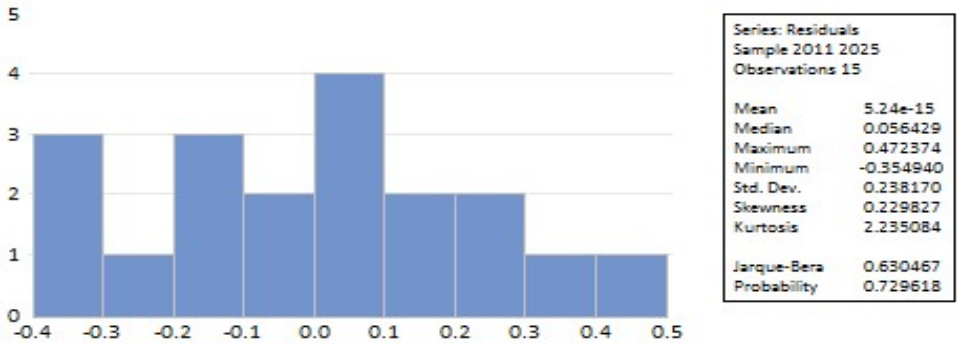


Figure 2. Results of the Jarque-Bera test on estimated residues

Source: Document prepared by the researcher based on the program results

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Therefore, the assessment form should be written as follows:

$$y_t = \beta_0 + \alpha_1 X_2 + \varepsilon_t \quad (4)$$

$$y_t = 10.837 + 5.239 X_2 \quad (5)$$

5.3. Economic analysis of the estimation results

Based on the estimation results of the selected econometric model and the signs of its estimated coefficients, the model appears to be economically consistent with the theoretical expectations underlying the relationship between entrepreneurial initiative and economic performance. Several theoretical approaches suggest that the development of micro-enterprises may be associated with higher levels of economic activity, employment creation, and income generation. These mechanisms provide a theoretical basis for examining the relationship between entrepreneurial initiative and economic development in Algeria, although their actual magnitude and causal effects cannot be established by the estimated regression alone.

The empirical results identify the explanatory variable X_2, representing the rate of micro-enterprise creation, as an important variable statistically associated with Algeria's GDP over the period 2011-2025. This finding is broadly consistent with economic theories emphasizing the potential contribution of productive enterprises to economic diversification, competition, and value creation. Nevertheless, the estimated association should be interpreted within the limits of the specified model and should not be taken as conclusive evidence that micro-enterprise creation independently causes changes in GDP.

From an economic perspective, the observed relationship may be explained by several mechanisms. First, the creation of micro-enterprises can contribute to broadening the productive base through the establishment of new production units operating in industrial, commercial, and service activities. Such expansion may support value-added creation and economic diversification. Second, micro-enterprises may contribute to employment generation, particularly among young people, thereby improving labor-market participation and potentially supporting aggregate productivity. However, the extent to which these mechanisms operate in Algeria during the period under consideration depends

on institutional conditions, enterprise productivity, access to finance, market demand, and other macroeconomic factors that may not be fully captured by the estimated model.

The relationship between micro-enterprise creation and GDP per capita may also be discussed through two potential channels. The first concerns employment and income generation, insofar as new enterprises may create job opportunities and provide income to entrepreneurs and workers. The second concerns the geographical distribution of economic activity, since micro-enterprises can operate in rural, inland, and urban areas and may therefore contribute to a broader distribution of productive opportunities. These mechanisms provide plausible economic explanations for the observed relationship, but their actual effects on income distribution and real GDP per capita cannot be directly established without additional indicators or empirical testing.

Regarding the estimated coefficient, the reported value of B = 5.239 must be interpreted in accordance with the functional form of the regression model and the measurement scales of the variables. If the model is specified in logarithmic form in a manner that supports an elasticity interpretation, the coefficient may indicate the percentage change in the dependent variable associated with a 1% change in the explanatory variable. Otherwise, the coefficient should be interpreted in terms of the units in which the variables are measured. Accordingly, the estimated result should not be interpreted as establishing that micro-enterprise creation causes a 5.239% increase in GDP growth unless the model specification and empirical identification strategy support that conclusion.

With respect to sustainable development, the findings provide a basis for discussing the potential relevance of micro-enterprises to its economic and social dimensions. Economically, micro-enterprises may support productive diversification and reduce, to some extent, the concentration of economic activity in hydrocarbon-related sectors. Socially, they may contribute to employment opportunities and economic inclusion, although the magnitude of these contributions requires direct empirical evidence. Environmentally, micro-enterprises may adopt sustainable production practices under appropriate technological, regulatory, and institutional conditions. However, since the present model does not directly measure environmental performance, no definitive conclusion can be drawn regarding their contribution to the environmental dimension of sustainable development.

Overall, the results indicate a statistically relevant relationship between micro-enterprise creation and the economic indicators examined in Algeria during 2011-2025. Their interpretation highlights the potential economic mechanisms underlying this relationship while recognizing that reverse causality, omitted macroeconomic variables, and the time-series properties of the data may affect the estimated results. Further research employing appropriate time-series diagnostics and, where feasible, a more robust causal identification strategy would be necessary to establish the direction and magnitude of any causal effects.

6. CONCLUSIONS

Based on theoretical approaches explaining the relationship between entrepreneurship and development, the economic literature, whether grounded in endogenous growth theories or structural diversification approaches, confirms that the dynamics of creating new production units drive improvements in productive efficiency, expansion of the economic base, and sustainable accumulation of physical and human capital. Small and micro-enterprises, thanks to their flexibility and ability to access diverse sectors and

geographic areas, contribute to increased competition, improved resource allocation, and higher overall factor productivity. This, in turn, has a positive impact on economic growth and per capita income. The results of the econometric component of our study are consistent with numerous studies that have addressed the issue of entrepreneurship and its economic effects. The study demonstrated that the growth rate of micro-enterprise creation is the most significant variable explaining GDP growth in Algeria over the period 2011--2025, with a considerable positive impact reflecting its role in supporting growth and strengthening its sustainable economic and social dimensions. This confirms that entrepreneurship is not simply a short-term option, but rather a structural driver of development. Regarding the Algerian experience, the analysis revealed a specific characteristic that necessitates distinguishing between different types of entrepreneurial initiatives. The impact of the start-up creation rate was excluded from the explanatory model because the environment conducive to this type of activity – in terms of financing, risk, innovation, technological infrastructure, and even the regulatory framework – is still evolving. It is therefore impossible to measure a stable and statistically significant impact over the period studied. Consequently, micro-enterprises have established themselves as the most entrenched and effective form of business in the Algerian economic landscape, thanks to their capacity for sectoral and geographic expansion, their contribution to job creation, the broadening of the production base, and the reduction of spatial disparities. They thus acquire a developmental dimension that transcends mere quantitative growth to achieve sustainable development in its multiple dimensions. This study therefore provides added value by highlighting the structural differentiation of the national entrepreneurial landscape and drawing attention to the models most likely to generate a real development impact in the current Algerian context. In conclusion, the main results of this study can be summarized as follows.

The econometric study demonstrated a positive and significant impact of the micro-enterprise creation rate on economic growth in Algeria over the period 2011-2025, thus confirming the role of entrepreneurship as a key driver of GDP growth.

The results of the benchmark estimate showed a strong positive impact of the microenterprise establishment rate on economic performance in Algeria, as a 1% increase in this rate was associated with a 5.239% increase in GDP, according to the specifications of the adopted model. This result gains its developmental significance from the fact that economic growth provides a material basis for expanding employment opportunities, accumulating human capital, and improving living standards, which may support community development through channels of transmission of income, skills, and economic opportunities. However, the achievement of these effects remains conditional on the extent to which the generated growth creates decent job opportunities, improves income distribution, and expands access to opportunities. Accordingly, the result supports the hypothesis of the economic role of entrepreneurial initiative as a potential input to community development, without considering the standard coefficient alone as direct evidence of the achievement of its social effects.

The study demonstrated that the impact of microenterprises in Algeria is not limited to increasing overall production, but also contributes to improving GDP per capita by creating new employment opportunities, boosting individual incomes, and strengthening the efficiency of distribution at the geographical and social levels.

The results revealed that microenterprises contribute to diversifying Algeria's production structure and reducing vulnerability related to dependence on the rentier sector, thus supporting the dimensions of sustainable economic and social development and

paving the way for the adoption of more environmentally friendly production practices. The study also revealed that the impact of start-ups in Algeria was not consistently high throughout the period studied. This is attributed to the inadequate preparation of the support environment in terms of venture capital, technological infrastructure, and the regulatory framework. Consequently, these start-ups were excluded from the optimal model in order to preserve its relevance.

The study concludes that the traditional microenterprise represents the most established and effective model in the current Algerian context, and that supporting it through structured financing and accompanying policies constitutes a strategic option for promoting sustainable development.

Therefore, we present below some recommendations from our study:

Strengthen the institutional framework.

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SYNERGY OF DIGITAL TRANSFORMATION AND PUBLIC GOVERNANCE FOR RAPID GROWTH OF SOCIO-ECONOMIC SYSTEMS IN LEADING COUNTRIES

The article examines the synergy between digital transformation and public governance as a driver of rapid socio-economic growth in leading countries. Based on comparative case studies of Estonia, Singapore, South Korea, Denmark, the United Kingdom, the United States, and the United Arab Emirates, supported by policy benchmarking, policy and data analysis, and indicative modelling to 2030, it shows that multiplicative effects arise not from technology alone but from its combination with state capabilities: whole-of-government coordination, data standards, trust governance, and budgetary and regulatory mechanisms. The novelty lies in operationalizing three synergistic linkages (eID + interoperability + open data; platform-based procurement + digital payments; data governance + proactive personalized services) and in identifying new systemic properties of digitally transformed socio-economic systems. A set of measurable KPIs (budget savings, transaction time, procurement competition, eID penetration, e-service uptake, citizen trust, digital economy share of GDP) and scenario-based growth benchmarks to 2030 are proposed.

Keywords: digital transformation, public governance, interoperability, digital procurement, socio-economic growth.

1. INTRODUCTION

Digital transformation has moved from automating individual functions to reconfiguring entire governance institutions, data, and services, transforming work design and leadership within organizations (Schwarzmüller et al., 2018). At the same time, technology alone does not guarantee economic dividends: the determining factor is a guided synergy – the ability of the state to combine digital solutions with strategy, budget rules, data standards, rights protection, and trust governance. It is precisely this combination that explains why some countries convert investments in ICT into tangible

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gains in productivity, inclusion, and quality of life, whereas others stall at fragmented "pilots". For example, the convergence of artificial intelligence and blockchain technologies requires synthesizing cognitive, institutional, and platform perspectives in order to form a holistic methodological foundation for studying public governance mechanisms in the era of algorithmic governance.

Digital transformation of public governance has become a key factor of modern development. Research shows that the implementation of digital technologies can accelerate economic growth and improve market indicators. From the perspective of public governance, the transition to a "digital government" increases transparency and accountability of authorities, reduces bureaucracy and corruption, and simplifies citizens' interactions with the state. In the social dimension, digital tools expand access to educational and medical services, promote social inclusion, and enhance well-being (Digital Regulation Platform, 2023). Importantly, these changes are underpinned by proper public governance – strategic vision and institutional reforms that ensure the effective use of digital solutions. It is the synergy of technology and good governance that creates a powerful multiplicative effect for socio-economic development.

The aim of the article is to analyze the public governance mechanisms that create and strengthen the synergy of digital transformation, and to show their socio-economic consequences on comparative examples of leading countries. The objectives are: to highlight the universal linkages between eID, interoperability, and open data; to assess the effects of platform-based procurement and digital payments; and to outline a set of KPIs for measuring results and to develop a moderate forecast to 2030. The object of the study is the digital transformation policies of states; the subject is the institutional mechanisms of their implementation that provide cost savings, productivity gains, and increased trust. The approach combines comparative analysis, content analysis of strategies and metrics, as well as synthesized results tables. In the study, policy benchmarking, analysis of public policies and data, comparative case studies, and indicative modeling through 2030 were applied.

2. METHODOLOGY

The selection of countries followed the logic of maximizing the variety of digital transformation models while maintaining comparability of their outcomes. Four criteria were applied. First, digital maturity: core cases consistently rank among the leaders of the UN E-Government Development Index (EGDI), so that synergistic effects have already materialized and can be measured. Second, diversity of transformation trajectories: radical systemic renewal in small states (Estonia, Singapore); technologically intensive modernization in developed democracies (Republic of Korea, Denmark); the platform-based model (United Kingdom); federated strategies of aligning institutional diversity (USA, Canada); directive, investment-driven digitalization (United Arab Emirates, China); and evolutionary transformation of transition economies (Poland). Third, institutional heterogeneity: the sample covers unitary and federal, small and large, democratic and non-democratic states, which makes it possible to distinguish mechanisms resilient to context from context-dependent factors. Fourth, availability and comparability of data from official statistics, international organizations and peer-reviewed studies.

Accordingly, seven countries (Estonia, Singapore, the Republic of Korea, Denmark, the United Kingdom, the USA and the UAE) form the core sample and are analysed in detail, while Finland, Canada, Poland and China serve as supplementary cases that broaden

the comparative context (McKinsey Global Institute, 2019). The inclusion of Poland and Estonia is of particular relevance for transition economies, including Ukraine, as they demonstrate how post-socialist administrative systems can achieve digital leadership. Taken together, these cases form an empirical "testing ground" of digital transformation, where each strategy delineates the boundaries of the possible and shapes a repertoire of solutions for further adoption (e-Estonia, 2025).

3. COMPARATIVE ANALYSIS OF PUBLIC GOVERNANCE MECHANISMS OF DIGITAL TRANSFORMATION IN LEADING COUNTRIES OF THE WORLD

The current stage of the digital transformation of socio-economic systems is accompanied by the emergence of new interdependencies between technological renewal and the institutional adaptation of public governance. Leading states exhibit different models of aligning digital innovations with structural changes in governance architectures, which allows identification of patterns of effective transformation. Estonia, the Republic of Korea, Singapore, Denmark, Finland, and other e-government leaders have developed their own mechanisms that simultaneously ensure technological self-sufficiency and sustain social cohesion (Kattel, Mergel, 2019). In 2015-2025, there has been a shift from the piecemeal digitalization of individual government functions to the holistic transformation of the entire socio-economic system. States with a high level of institutional integration demonstrate faster rates of digitalization and better results in the availability of e-services for citizens (McKinsey Global Institute, 2019). In these conditions, socio-economic systems develop an "adaptive reflexivity" capability – self-correcting based on the analysis of their own digital footprints and behavioral patterns (Kattel, Mergel, 2019). Public governance, in turn, is evolving from traditional hierarchical coordination to algorithmic alignment (orchestration) of a multitude of actors and processes.

Estonia demonstrates one of the most stable models of digital statehood, in which the transformation of the socio-economic system is based on the principles of "digital by default" and "once-only". The solution's architecture rests on three interrelated elements: digital identification as the foundation of citizens' rights, interoperability of state registers via the X-Road platform, and data-driven service delivery (Kitsing, 2011). A distinguishing feature of the Estonian approach is the formation of a "seamless" digital ecosystem, where 99% of public services are available online (including electronic voting, business registration, tax filing) (Björklund, 2016). The "governance by intermediarization" mechanism envisions delegating to private actors the roles of infrastructure stewards, which enhances flexibility while maintaining state oversight (Margetts, Naumann, 2017). As a result, Estonia's socio-economic system attains the property of "network resilience" – the ability to maintain continuity of critical services even under physical threats thanks to distribution and duplication.

South Korea has developed a "smart governance" model characterized by the embedding of artificial intelligence and big data into decision-making processes. Emphasis is placed on participatory budgeting, citizens' digital participation in policymaking, and the use of data analytics for the preventive management of social risks (Kim, Lee, 2012). During the COVID-19 pandemic, Korea's "digital resilience" manifested in rapid testing and contact tracing based on mobile technologies, AI tools, and interagency coordination. A key feature of the approach is the combination of centralized planning with decentralized execution (broad engagement of business and civil society), which allows maintaining

a balance between radical innovation and systemic stability (Chan, Nurrosyidah, 2025; Park, Samijadi, 2021). As a result, South Korea's socio-economic system has developed "contextual adaptability" – the ability to quickly readjust interactions in response to external challenges; public governance has acquired features of "preventive governance", whereby problems are identified based on analysis of big data even before they escalate.

Singapore exemplifies a "whole-of-government" approach to digital transformation with an emphasis on systemic integration and data-driven optimization of urban processes. The Smart Nation initiative entails creating a comprehensive infrastructure – sensor networks, big data analytics, AI for managing transport, energy, security, and more. The core mechanism relies on the principle of "digital twinning" – developing digital twins of physical systems for modeling and optimizing decisions. The GovTech Singapore agency coordinates the development of common digital components and a standardized technological architecture while preserving agency flexibility (Tan, Mahizhnan, 2018). The national digital identity SingPass has evolved from an authentication tool to an integrated platform that connects government and private services through a single interface. Such a configuration endows public governance with the quality of "predictive intelligence" – the ability to detect socio-economic trends in advance based on large-scale analytics and to adjust development strategies accordingly.

Denmark has developed a model of "citizen-centric digital transformation", wherein the implementation of innovations is systematically oriented toward the needs of citizens. A high level of mutual trust between the state and society made it possible to implement changes with minimal resistance (Schou, Hjelholt, 2018). The concept of a "digital welfare state" integrates social services with digital technologies and provides personalized service delivery based on life events. The mandatory Digital Post electronic mailbox covers 93% of the population, creating a unified channel of official "state-citizen" communication (İnel, 2019). The combination of high social capital and a culture of trust has been the key success factor; as a result, the Danish system acquires "empathetic adaptability" – the ability to take into account individual citizens' needs during process automation, and public governance is moving toward "personalized governance" with individualized service bundles corresponding to life situations.

United States of America. Digital transformation in the US is mosaic in nature, reflecting the federal structure and the dominant role of the private sector in innovation: large technology firms have largely shaped the turn of public management towards data science and artificial intelligence (Margetts, Dunleavy, 2024). The United States Digital Service (USDS) and 18F teams drive the modernization of federal IT through private-sector practices, but they run up against a legacy of outdated solutions, some of which date back to the 1970s (İnel, 2019). The absence of a single national electronic identity complicates integrated service delivery; instead, partial tools are used – for example, Login.gov, which covers about 40 million users (less than 15% of the population) (United Nations Conference on Trade and Development, 2024). The US leads in the adoption of AI in the defense sector, whereas in the civilian sector the scale of applications is held back by privacy concerns. As a result, the socio-economic system exhibits "technological heterogeneity" – the coexistence of cutting-edge innovations and obsolete platforms across different industries; public governance is characterized by "innovative enclaves" that stand out against the backdrop of overall heterogeneity.

United Kingdom. As early as the 2000s, the country formulated a "Government as a Platform" (GaaP) approach, aimed at creating common digital components and services for all agencies. The Government Digital Service (GDS) unit introduced mandatory design

and development standards that ensured a unified user experience across government online services. The GOV.UK portal, visited by tens of millions of users each month, replaced over 2,000 separate government websites. The transformation relies on user-centric principles and agile development methodologies (with short sprints) (National Audit Office, 2021; UK Government Digital Service, 2012). Exiting the EU created additional pressure on this domain, leading to the development of the UK's own data standards. As a result, public governance acquired "user-centric adaptability" – the ability to respond quickly to changing citizen expectations through continuous testing of solutions (including A/B experiments).

United Arab Emirates. The UAE demonstrates a high level of digital maturity: in 2024 it ranked 11th in the world in the UN E-Government Development Index (EGDI) with a score of 0.9533, up from 13th place (0.9010) in 2022 (United Nations, 2024). The state combines massive investments with technological innovations: Dubai implemented a fully paperless strategy by 2021, which saves over 336 million sheets of paper and 13 million person-hours annually (e-Estonia, 2025). An institutional infrastructure for AI and blockchain has been created (a Minister of State for AI position, the AI Strategy 2031, Blockchain Strategy 2021), and the national e-identity system UAE Pass provides access to most government and private services through a single login. The digital economy's share of GDP reached about 9.7% in 2022 and continues to grow (e-Estonia, 2025). The digitalization policy is oriented toward improving quality of life ("happiness agenda") and building transparent, proactive governance; as a result, the socio-economic system shows a high speed of change and innovation with an active role of the state, and public governance is characterized by significant digital readiness and an aspiration for global leadership.

The other countries in the sample also significantly broaden the analytical field. Finland is advancing a model of collaborative digital governance with active involvement of civil society; it is characterized by a high level of population digital competence and a systematic emphasis on ethics and the protection of digital rights (specialized ethics committees are in operation) (Edwards, 2025). Canada is developing a federated trajectory of digitalization that accounts for multiculturalism and relies on the principle of "privacy by design"; coordination is carried out by the Treasury Board Secretariat, and the launch of algorithmic solutions is accompanied by a mandatory human rights impact assessment (Clarke, Lindquist, Roy, 2017). Poland adheres to an evolutionary logic: under the "Cyfrowa Polska" program and with the support of EU structural funds, it is consistently strengthening digital infrastructure and citizens' skills; the mObywatel mobile application became a breakthrough in e-services and already has over 8 million users (McKinsey & Company, 2016). China exhibits an unprecedentedly large-scale, state-driven digitalization: the "Digital China" strategy envisions investments of over $1.4 trillion by 2025; a unified national government services platform has been created for 1.4 billion people, an algorithmic social credit system has been implemented, and a national digital currency (CBDC) introduced (Roberts et al., 2023; United Nations Conference on Trade and Development, 2024). Taken together, these cases underscore the decisive role of context – from cultural norms to politico-institutional frameworks – in achieving synergy between technological transformations and public governance.

Thus, despite differing approaches, common results and new systemic properties are observed under the influence of digital transformation. In particular, these include adaptive reflexivity, algorithmic orchestration, network resilience, contextual adaptability, preventive governance, predictive intelligence, empathetic adaptability, personalized

governance, collective wisdom, multicultural adaptability, federative digital governance, catch-up modernization, service-oriented governance, technological heterogeneity, innovative enclaves, algorithmic determinism, digital authoritarianism, user-centric adaptability, etc. Their definitions, manifestations, and governance implications are summarized in Table 1.

Table 1. Emergent systemic properties of digitally transformed socio-economic systems and their implications for public governance

Property	Definition	Manifestations in socio-economic system	Implications for public governance
Adaptive reflexivity	Ability to self-correct based on analysis of digital footprints	Automatic process optimization, learning from own data	Transition to evidence-based policymaking
Algorithmic orchestration	Coordination of actors via algorithms instead of hierarchies	Platform economy, automated coordination of resources	Transformation of the state's role from controller to facilitator
Network resilience	Resilience through distribution and duplication	No single point of failure, self-recovery of systems	Decentralization of critical infrastructure
Contextual adaptability	Rapid reconfiguration of processes in response to external challenges	Flexible response to crises, personalization of interactions	Situational governance instead of universal rules
Preventive governance	Anticipation of problems before they escalate	Predictive analytics, early warning of risks	Proactive policies instead of reactive ones
Predictive intelligence	Forecasting trends based on data	Proactive adaptation of infrastructure and services	Strategic planning based on AI
Empathetic adaptability	Considering individual needs in automation	Personalized social programs, contextual support	Balance of efficiency and humaneness
Personalized governance	Unique services for each citizen	Life-event approach, proactive service delivery	Transformation from mass solutions to individual solutions
Collective wisdom	Aggregation of knowledge from diverse groups for better decisions	Crowdsourced policymaking, public consultations via AI	Democratization of expertise
Multicultural adaptability	Considering cultural characteristics of different groups	Culturally sensitive algorithms, adaptive interfaces	Inclusive policy design
Federative digital governance	Autonomy of government levels with common standards	Interoperability without centralization	Balance of unity and diversity
Catch-up modernization	Rapid implementation of best practices	Skipping intermediate stages of development	Accelerated transformation

Property	Definition	Manifestations in socio-economic system	Implications for public governance
Service-oriented governance	Focus on user needs	UX design of public services	Client-centricity instead of bureaucratic logic
Technological heterogeneity	Coexistence of various technological generations	Uneven development across sectors	Managing technological fragmentation
Innovative enclaves	Islands of excellence amid overall backwardness	Local breakthroughs without systemic transformation	Point successes instead of comprehensive changes
Algorithmic determinism	Subordination of social processes to algorithms	Algorithmic management of behavior	Automation of social control
Digital authoritarianism	Total control through digital technologies	Social scoring, digital surveillance	Technological reinforcement of authoritarian power
User-centric adaptability	Quick response to changing citizen needs	Continuous A/B testing of policies, iterative improvement	Agile governance instead of long planning cycles

Source: author's development based on the comparative analysis of national cases.

The indicators used to assess the effects of digital transformation were selected according to three principles. First, causal relevance: each indicator reflects the outcome of a specific synergistic linkage rather than digitalization in general. Budget savings and transaction time capture the effects of "eID + interoperability"; competition in public procurement and SME participation capture those of "platform-based procurement + digital payments", as illustrated by the Korean e-procurement system KONEPS (Global Partnership for Effective Development Co-operation, 2021; OECD, 2016); satisfaction with services and trust in institutions capture those of "data governance + proactive services". Second, measurability and cross-country comparability: all indicators are regularly published by international sources (UN EGDI, OECD, Eurostat DESI, World Bank, UNCTAD) or national digital agencies. Third, multi-level coverage: the set spans the fiscal, procedural, market, social-institutional and macroeconomic levels, from a single administrative procedure to the digital economy's contribution to GDP. This makes it possible to trace how micro-level efficiency gains translate into macro-level growth.

The above synergistic effects of digital transformation directly translate into an increase in societal well-being and economic dynamism. Table 2 presents specific KPIs of digital solutions and their impact on well-being in selected countries and in the global dimension.

According to calculations by McKinsey Global Institute, scaling electronic identification and interoperable registers could add up to 13% of GDP to economies by 2030 (McKinsey Global Institute, 2019). This confirms that combining digital solutions with effective governance institutions significantly accelerates socio-economic growth. The experience of leading countries shows that integrating innovations with adaptive governance mechanisms ensures a rapid increase in well-being and competitiveness of national systems.

Table 2. Synergy of eID–interoperability–open data: effects and forecasts

Country/ Mechanism	Key measures	Effect indicators (facts)	Implications for well-being	Short forecast to 2030
Estonia – eID, X-Road, e-signature	Single digital identity; interoperability of registers; "once-only" principle	Savings ~2% of GDP each year; tax declaration takes minutes	Lower time costs for households; increased trust; better business climate	"Invisible services" and automation (zero bureaucracy); sustaining macro-level impact
Singapore – SingPass, open data, Smart Nation	Single eID; data integration; API ecosystem; digital literacy programs	Digital economy constitutes 18.6% of GDP (2024); 14.5% of SMEs use AI	Faster transactions; higher incomes in digital professions; digital inclusion of older age groups	Further growth in digital economy contribution; diffusion of AI beyond the ICT sector
Globally – potential of eID (MGI)	Scaling digital identity and interoperability of registers	Additional +3–13% of GDP by 2030 (depending on country)	Formalization of interactions; broader access to services and financing	Conservatively: +2–5 percentage points to baseline GDP growth scenario

Source: author's compilation based on (e-Estonia, 2025; European Commission, n.d.; Infocomm Media Development Authority, 2025; International Peace Institute, 2016; McKinsey Global Institute, 2019).

4. SOCIAL AND INSTITUTIONAL EFFECTS: INCLUSION, LITERACY, TRUST

The synergy of digital technologies and public governance has a powerful social dimension. Digital inclusion of the population grows noticeably when state policy is aimed at expanding access to the internet and online services for all segments of the population. In advanced digital states today, almost all citizens are connected to the network: for example, in Canada 93% of the population has basic access to high-speed internet (50 Mbps) (Kwok, Korpela, 2024), and in urban agglomerations this figure approaches 98-99%. However, infrastructure by itself is only part of the solution. High results are achieved when, alongside access, the state invests in digital literacy and motivates citizens to use electronic services. Finland has one of the most successful national digital literacy programs: digital skills have been integrated into the school curriculum, continuous courses are offered for adults, and special attention is given to vulnerable groups. The result is that 82% of Finns aged 16-74 possess basic or above-basic digital skills, whereas the EU average is only 56% (Kwok, Korpela, 2024). Thanks to this, Finns can effectively use online services regardless of age or place of residence, and the generational gap in the use of digital technologies is minimized. By contrast, Canada until recently focused primarily on developing internet infrastructure, neglecting issues of skills and services, which was reflected in its positions in global rankings (47th place in digital inclusion) (Kwok, Korpela, 2024). The experience of the Nordic countries indicates that only a comprehensive approach – infrastructure + education + digital services – can ensure true digital inclusion of the whole society.

Improving digital literacy and service accessibility is closely linked to increases in the Human Development Index (HDI). Countries leading in e-government development generally also have very high HDI indicators, since digital services improve people's access to education, healthcare, information, and economic opportunities. The United Nations recognizes that digital transformation is a necessary condition for achieving the Sustainable Development Goals by 2030 (Kwok, Korpela, 2024). In other words, without digital inclusion and modern governance, it will be difficult for countries to ensure a steady improvement in citizens' quality of life. In Finland, for example, the digitalization of the state is implemented under the motto "digital state for all," and the country ranks among the world's top ten in metrics of IT use for social engagement and inclusion (Kwok, Korpela, 2024). Through its national "Digital Compass 2030" strategy, the Finnish government simultaneously develops digital skills, services, infrastructure, and business support (Kwok, Korpela, 2024). As a result, citizens receive human-centric public services – convenient, personalized, and available online for everyone (Kwok, Korpela, 2024). This is especially important for remote regions, people with limited mobility, and people with disabilities – digital services lower barriers and provide equal opportunities for access to government services.

An equally significant consequence of the synergy of digitalization and good governance is the increase in citizens' trust in government. When public services become more open and responsive, citizens begin to perceive the government as more effective and transparent, which raises the level of trust. Academic studies confirm a positive correlation: under favorable conditions, the use of e-services increases citizens' trust, especially if they evaluate those services as effective (Lee-Geiller, 2024). Interestingly, digital literacy serves as an effective catalyst here: people who confidently use online services tend to trust the government more, perceiving its openness and customer-orientation (Lee-Geiller, 2024). The reason is simple – digital services reduce queues, subjectivity, and corruption risks, while increasing transparency and accountability of the authorities.

For example, in South Korea the implementation of electronic platforms (open data portals, online complaint systems, budget tracking, etc.) became a tool for combating corruption and contributed to increased trust in state institutions (World Economic Forum, 2023). Korea has remained among the world's leaders in the UN E-Government Development Index for more than a decade: it ranked 1st in 2010-2014, stayed in the top three until 2022 and placed 4th in 2024, ranking 1st on the Online Service Index (United Nations, 2024). This reflects not only the technical excellence of its digital systems but also citizens' high evaluation of government performance. Similarly, the United Kingdom, after launching the unified GOV.UK portal and other digital initiatives, noted growth in citizens' satisfaction with public services. Governments that actively adopt a "digital-first" principle gain not only cost savings but also public appreciation for convenience – and this directly affects the level of trust in the authorities.

Of course, technology alone will not solve the trust problem: it is important that digital transformation be accompanied by real improvements in service quality and transparency (otherwise disappointment could instead undermine trust). But overall, when public governance puts the citizen at the center of digital transformations, the social contract between the state and society grows stronger.

5. DISCUSSION

The relevance of the topic is determined by the fact that digital transformation has ceased to be a sectoral technological task and has become a factor of the state's strategic competitiveness. Large-scale investments in ICT do not by themselves guarantee economic dividends: many countries remain at the stage of fragmented pilot projects, "innovative enclaves" and technological heterogeneity. Understanding which combinations of technologies and governance institutions turn digital investment into measurable growth in productivity, inclusion and trust is therefore of direct practical importance for governments, especially for transition economies and countries facing post-crisis recovery, where the cost of ineffective digitalization is particularly high.

The study yields several new results. First, unlike works that analyse individual national cases or single instruments, such as the Estonian X-Road model (Kattel, Mergel, 2019) or the Government-as-a-Platform concept (Margetts, Naumann, 2017), it identifies three cross-national synergistic linkages – "eID + interoperability + open data", "platform-based procurement + digital payments" and "data governance + proactive personalized services" – which produce multiplicative rather than additive effects. Second, on the basis of comparing seven core and several supplementary cases, a typology of eighteen emergent systemic properties of digitally transformed socio-economic systems is proposed (from adaptive reflexivity and network resilience to digital authoritarianism), with their manifestations and implications for public governance (Table 1). This typology shows that digital transformation can strengthen both democratic and authoritarian governance trajectories, depending on the institutional context. Third, the effects of digital solutions are linked to a set of measurable KPIs and moderate growth benchmarks to 2030, which allows the concept of synergy to be translated into a tool for monitoring public policy. The findings are consistent with research confirming the positive impact of e-services on citizens' trust (Kim, Lee, 2012) and with estimates of the macroeconomic potential of digital identification (McKinsey Global Institute, 2019), while specifying the institutional conditions under which this potential is realized. They also develop the author's earlier concept of transitive statehood in the digital era (Sikalo, 2025).

At the same time, the study has limitations. It relies predominantly on secondary data and official reports, which vary in methodology and reference years. The forecast to 2030 is indicative and scenario-based rather than econometric. The selection of countries favours digital leaders, which may overestimate the transferability of their solutions. Further research should focus on quantitative verification of the proposed synergistic linkages using panel data, on adapting the KPI set to countries with lower digital maturity, and on the risks of algorithmic governance for human rights and democratic accountability.

6. CONCLUSIONS AND OUTLOOK TO 2030

The comparative analysis confirms that the synergy of digital transformation and good public governance has become a powerful driver of socio-economic progress, but only where digital solutions are embedded in strategy, institutions and trust governance. The maximum results are achieved not by investment in technology as such, but by integrated packages of solutions – "eID + interoperability + open data", "platform-based procurement + digital payments" and "data governance + proactive services" – which reduce transaction costs, strengthen competition and market transparency, and translate into measurable gains: lower public and private expenditures, shorter procedure times, wider SME participation

in procurement, higher trust in institutions and a growing contribution of the digital economy to GDP.

To scale such effects, governments need unified data standards and interagency interoperability; shared platforms (identity, payments, procurement) as basic "government modules"; trust governance ensuring transparency, data security and ethics; and continuous KPI monitoring with feedback loops to citizens and businesses. A moderate scenario through 2030 anticipates additional gains from digital identity, platform-based procurement and automated services, provided that the main "bottlenecks" – legacy systems, deficits in digital skills, misaligned registers and privacy risks – are removed.

By 2030 the role of this synergy will grow further. The EU's Digital Compass sets the targets of at least 80% of adults with basic digital skills, all key public services available online and the use of eID by the majority of citizens (European Commission, 2021), while national strategies – Estonia's "invisible government" (European Commission, n.d.) and Korea's Digital Platform Government (World Economic Forum, 2023) – aim at proactive, largely automated service delivery. Thus, the synergy of technology and good governance is shifting from the format of an "IT project" to the rank of a strategic operational function of the state, generating sustainable socio-economic advantages.

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