

DETERMINANTS OF ECONOMIC COMPETITIVENESS IN THE CONTEXT OF THE GREEN AND DIGITAL TRANSITION

MITRACHE LAVINIA ADELINA

PHD STUDENT "EUGENIU CARADA" DOCTORAL SCHOOL OF ECONOMICS SCIENCES,
UNIVERSITY OF CRAIOVA, ROMANIA

e-mail: mitrachelavinia6@gmail.com

Abstract

The paper analyzes the key drivers influencing economic competitiveness within the European green transition and digital transition frameworks. Economic competitiveness is viewed within this paper as the ability to drive sustained economic growth, productivity, and social well-being via innovative mechanisms and strategic public policies. Current literature on this topic produced by the European Commission, OECD, and World Economic Forum suggests that there are four overarching drivers influencing competitiveness: structure, institutions, technology, and environment. The importance of digitalization is stressed as a factor which increases efficiency, transparency, and innovative capability. The green transition is also supportive of competitiveness, which favors eco-innovation, responsible resource management, and low carbon production. The two processes involve complementary effects which give rise to a new paradigm within which sustainability and technological change play a pivotal role. This paper also covers the situation of Romania within the European Union, pointing out the structural weaknesses present within Romania concerning innovation, digital competence, and institutional efficiency, but also highlighting opportunities deriving from access to European funds, implemented within the framework of National Recovery and Resilience Plans. The results confirm that modern competitiveness is no longer solely based on more traditional factors such as costs of labor and export prowess. Rather, competitiveness is increasingly linked to the capacity to balance technological change with environmental sustainability, to build development resilience and to develop inclusive development approaches that can meet policy.

Keywords: competitiveness, green transition, digital transformation, sustainable development, innovation

Classification JEL: O44, Q55

1. Introduction

Within a world scenario characterized by deep and rapid structural transformations, economic competitiveness has assumed a primary role in evaluating the resilience and viability of modern economies. It should be noted that, given the evolution of the world scenario, modern economies are faced with a new reality, as they are no longer competing as a result of low labor costs or traditional competitiveness, but due to their innovative potential, their flexibility, or their capacity to fully absorb sustainability principles into their model of development. It is within this scenario that the twin transition has assumed a primary role as a paradigm in economic competitiveness.

The European Union, as embodied in a series of strategic plans most importantly, The European Green Deal from 2019, The Digital Decade Policy Program from 2030, and The Updated Industrial Strategy from 2024, progresses in support of a competitive, resilient, and climate-neutral economy that can support our economic prosperity in a world which operates under planetary boundaries. In this context, competitiveness shifts in significance from a value being pursued as an end goal in itself to a means in support of sustainable, equitable, and innovative development, as described in The 2030 Agenda for Sustainable Development.

With a focus on Member States of the European Union, especially those with emerging economies in Eastern Europe, like Romania, it appears that the integration of green and digital aspects in the economic structure plays a major role in encouraging competitiveness. This has been a paradigm shift that has greatly impacted investment, research, and education, but also has a significant role in other sectors. Therefore, this article aims to explore and uncover the forces that drive economic competitiveness in the perspective related to both the green economy and digital economy, with a view to understanding and uncovering the determining factors in economic

competitiveness from a structural, institutional, and sustainable point of view for states in the referred area, known as European states.

2. Theoretical foundation of economic competitiveness

The idea of competitiveness of the economy has a prominent place in studies of the performance of contemporary states, as it has been related not only to prospects for economic growth but also to responsiveness in conditions of structural and technological changes. Scholarship has defined competitiveness as an economy's potential to provide goods and services that are able to support a high income and employment level along with a stable macroeconomic environment. Michael Porter (1990) was one of the earliest academics able to identify the national competitive advantage in an integrated approach known as the Diamond Model, based upon factor conditions, home market, linked industries, and national business strategies. This perspective can be supported by another conceptual framework in international economics, in which Paul Krugman (1994) emphasized the risk of confusing competitiveness with the current balance of trade and advocating that competition should be seen not just in terms of outcomes or achievements in foreign markets but in terms of process.

The World Economic Forum (2024) describes competitiveness as factors that affect a country's productive potential. With regard to the Global Competitiveness Index 4.0, it would be feasible to assess competitiveness from various dimensions, which range from institutions, infrastructure, education, macroeconomic environment, business dynamism, to innovation.

Modern strategies promoted by Organisation for Economic Co-operation and Development (OECD, 2024) and the European Commission (2023) are focused on competitiveness in relation to sustainability, innovation, and social inclusion. Strategies of the European Union point to competitiveness as a motive for efficient, sustainable, and robust growth in Europe. This arises from strategies such as the European Green Deal in 2019, Digital Decade Policy Programme in 2030, and European Industrial Strategy in 2024. Another strategy, Draghi Report, of 2024, examines competitiveness in the European Union and asserts five priority areas. These areas include investment, regulation, innovation, capital, and skills. Strategic autonomy, as described in this report, means improvement in all of these five sectors.

2.1 Evolution of the concept and multidimensional approaches

The literature in economics has evolved quite substantially in terms of conceptual understanding regarding the nature of competitiveness. While earlier literature emphasized the crucial role of various forms of comparative advantages and cost of production factors, more contemporary research has evolved toward taking up a more encompassing perspective regarding competitiveness in general. This now involves not only technological considerations but also institutional and cultural factors; both are deemed to play crucial roles alongside technological factors (Esser et al., 1996).

With the European Commission's perspective in 2024 in mind, competitiveness cannot be seen from only one point of view. This involves not only productivity and innovation but also sustainability in an interdependent context. The latest European strategy views the link between industry policy, the digital transformation, and the green transformation in terms of securing a growth model based on innovation and efficiency.

According to the Draghi Report in 2024, ensuring Europe's competitiveness in the future is only possible through a 'double transition' in the structure of the economy. This double transformation occurs through both the decarbonization and digitalization of the economy and foresees new dimensions regarding the determinants of competitiveness and research opportunities in areas like human capital and investment in information technologies.

2.2 Green transition and digital transition

The green and digital transitions are now known to be structural determinants in current competitiveness. Recent evidence from the Joint Research Centre in 2023 suggests that digitalization can contribute to improving energy efficiency and productivity and accelerate innovation, although it may also trigger imbalances due to high-energy use and data infrastructure dependence.

With respect to the issue of the environmentally driven transformation, the idea is to achieve the decoupling of economic expansion from the intensive use of natural resources and minimize carbon emissions. According to Păduraru (2023), eco-innovation embodies the key competitiveness factor in that particular context thanks to the encouragement of both resource efficiency and the diversification of best available business models. The role of technological innovation in improving overall economic performance in the context of environmental constraints has been further supported by Curteanu (2021).

At the firm level, Spulbar et al. (2024) argue that the combination of digitalization and ESG factors has positive outcomes in terms of regional competitiveness and business sustainability. Technological progress and social responsibility are harmoniously combined in business in such a way that companies are able to strike a balance between economy and the environment.

For this reason, today's competitiveness relies on the capacity of economies to capitalize on the complementarity between digitalization and sustainability in turning both trends into innovation engines.

2.3 Determinants of economic competitiveness

Examination of current research indicates there are four overall categories of factors:

- **Structure:** This refers to features such as the country's infrastructure, education levels in the country, the effectiveness of value-chain linkage, and the level of free trade. Productivity levels in many developed countries are high because of advanced digital infrastructure and qualified workers.
- **Institutional factors:** quality of governance and macroeconomic stability. Institutions are determinants that minimize transaction costs. A bureaucracy-ridden country or one that lacks transparency may hamper competitiveness.
- **Innovation and digitalization factors:** research and development spending, digital abilities, and entrepreneurship infrastructure. Evidence from Amfiteatru Economic (2023) and UTM (2022) suggests that innovation levels are positively linked to economic competitiveness.
- **Sustainability factors** include energy efficiency, the shift towards the circular economy, and green investment. According to Păduraru (2023), eco-innovation and ESG governance help companies create sustained competitive advantage.

All the factors are interdependent. Digitalization drives innovation, good governance attracts investment, and sustainability creates value.

2.4 Measurement models and methodological implications

The competitiveness in the economy can be measured using multi-criteria models that take into consideration a vast number of factors. Among those factors, the most commonly used tool in this context is the Global Competitiveness Index (GCI 4.0), developed by the World Economic Forum. The index encompasses the conventional factors of competitiveness and those regarding innovation and sustainability.

Recently, the European Commission proposed a new tool that has become generally known under the name Competitiveness Compass (European Commission, 2024). This tool monitors member states' progress in each of the nine areas: single market, productivity, innovation, digitalization, energy, capital, skills, supply chains, and strategic autonomy. The tool expresses the

priorities of European policymaking in matters of sustainable competitiveness in Europe and has now been integrated into the process of twin transitions.

The OECD (2024) presents a unifying view regarding the issue of competitiveness in connection with technological change and social sustainability. This discourse provides opportunities for analyzing cause-and-effect relations in connection with innovation, digital transformation, and overall sustained economic performance.

The specialized literature reveals that there are signs that competitiveness cannot be reduced exclusively to the issue of production efficiency or cost factors. It should be defined from the point of view of the system in terms of infrastructure, human resources, institutional factors, innovation, and sustainability.

Yet, the challenges in realizing the transformation towards green and digital economics are imminent in today's economics. The demands of today's generation can be restated through the challenges outlined above; this may reshape the factors that determine the gainful comparative advantage and strengthen economics' resilience. Today's competitiveness factors include innovation, sustainability, and good governance.

3. Empirical and applied perspectives on competitiveness within the twin transition

The empirical studies carried out in European economies tend to support the thesis that the factors outlined in the theoretical framework are not homogenous in different settings defined by different levels of structural capacity, institutional development, and the rate of digital and environmental technology uptake. The findings from the European Commission's DESI Report demonstrate that European countries characterized by advanced digital infrastructure, widespread digital competence, and embracing the use of cloud-enabled and data-intensive technologies are more likely to be marked by stronger productivity and innovation performance (European Commission, 2023). This result confirms other research analyses carried out in European economies that digital competitiveness boosts European exporters' competitiveness and technological progress.

Environmental transformation provides proportional outcomes. According to OECD analysis results, those states that apply continuous investment in the renewable energy sector, resource efficiency, and the circular economy bring more effective competitive advantages based on reduced costs, optimized risk analysis, and increased levels of innovation (OECD, 2024). The study conducted in Eastern European context validates information regarding the fact that environmentally based innovation boosts business resilience and resource productivity in combination with adaptive competitiveness (Păduraru et al., 2023). Moreover, according to data presented by Curteanu et al. (2021), companies that implement business-oriented environmental responsibilities exhibit more consolidated effective outcomes in terms of sustainable development.

At the intersection point of these changes, research reveals that digitalization and being environmentally responsible are compatible factors. Martínez-Caro et al. (2020) conclude that there is more productivity and overall effectiveness in companies that use digital technologies in combination with business processes centered on sustainability. Likewise, Spulbar et al. (2024) conclude that companies' use of digital systems in the context of environmental, social, and governance initiatives increase overall regional competitiveness.

Based on the information from Romania, there are clear improvements in digital public services and the diversification of energy resources but persisting weaknesses in innovation, digital competence, and institutional effectiveness. The comparative data indicates that those countries linking digital competitiveness with environmental objectives are more resilient and more competitive in the future (Dima et al., 2018). This would mean that the country's chance of closing the gap in the twin transitions relies largely on investment, regulatory stability, and innovation in the same strategic framework.

3.1 Practical Indicators of Competitiveness in the Twin Transition

A practical evaluation of competitiveness requires the use of measurable indicators that capture the effects of digital and environmental transformation on economic performance. One widely used framework is the Global Competitiveness Index developed by the World Economic Forum, which includes institutions, innovation capacity, infrastructure and market efficiency as core elements influencing competitive performance (WEF, 2023). Countries scoring well in innovation and digital capability tend to achieve superior economic outcomes, confirming the link between technological advancement and competitiveness.

Digital performance indicators also provide valuable insights. The Digital Economy and Society Index measures connectivity, digital skills, business integration of digital tools and the digitalisation of public services. Research shows that states with strong DESI values exhibit significantly higher productivity and innovation output (European Commission, 2023). Empirical results from Martínez-Caro et al. (2020) demonstrate that digital technology adoption improves decision making, organisational adaptability and the speed of innovation diffusion, all of which drive competitive advantage.

Environmental indicators complement this analysis. Eurostat and OECD monitor renewable energy use, emission reduction, recycling rates and the efficiency of resource use. Kiefer et al. (2019) show that environmental performance contributes directly to competitiveness by reducing operational risks and enabling firms to enter new sustainability oriented markets. Research on eco innovation in Eastern Europe emphasises that countries and firms integrating environmental responsibility into production systems record higher resilience and stronger long term competitive behaviour (Păduraru, 2023).

In the case of Romania, these indicators reveal important contrasts: while progress has been registered in renewable energy production and in aspects of digital public administration, digital skills, innovation output and business digitalisation remain below the European average (OECD, 2024). Evaluating these indicators together shows that Romania's path to enhanced competitiveness will depend on deeper integration of digital capabilities with sustainability objectives, supported by coherent investment strategies and institutional reform.

3.2 Comparative Analysis: Romania and the European Union

A comparison between Romania and the European Union shows that there are substantial differences caused by the different levels of adaptation regarding digital and green technologies. Based on the Digital Economy and Society Index, Romania is one of the lowest-rated EU member states regarding digital competence indexes and the use of advanced technologies and digital business, although there are improvements in infrastructure indexes caused by recent investments (European Commission, 2023). The same conclusion emerged in other studies regarding competitiveness in the Central and Eastern European regions, confirming the essential role of digital preparedness in terms of innovation and exports.

Regarding the environmental dimension, Romania's positioning appears relatively balanced. The progress in clean technologies and reduced emissions corresponds with the overall regional pattern, although the achievement of the circular economy appears relatively less advanced compared with the leaders in the European Union (OECD, 2024). The fact that research regarding the eco-innovation process in the context of Eastern Europe depicts those regions embedding environmental goals in industry policies gaining enhanced resilience and more successful competitive outcomes (Păduraru, 2023; Curteanu, 2021) should be noted. At the same time, research regarding comparative data in terms of sustainable competitiveness illustrates that those economies strengthened in both digital transformation and environmental accountability appear more advanced in terms of productivity (Dima et al., 2018).

For Romania, factors like institutional quality, human capital, and research capacity remained obstacles in the process of convergence. However, data indicates that collectively funded efforts via the National Recovery and Resilience Plan create favorable circumstances in overcoming competitiveness gaps (Spulbar et al., 2024).

3.3 Conceptual Model for Applied Competitiveness in the Twin Transition

A conceptual model explaining applied competitiveness under the twin transition can be built around three interconnected components: digital capability, environmental responsibility and institutional effectiveness. Digital capability includes infrastructure, digital skills and technology adoption, all of which influence productivity and innovation. Research in European economies demonstrates that firms integrating artificial intelligence, cloud computing and advanced data systems achieve superior competitiveness outcomes (Martínez-Caro et al., 2020).

Environmental responsibility reflects the degree to which economies integrate renewable energy, resource efficiency and circular practices. Eco innovation research in Eastern Europe shows that environmentally oriented firms develop more resilient and cost effective business models (Păduraru, 2023), while comparative evidence confirms that environmental investments are increasingly associated with improved productivity and export capacity (Kiefer et al., 2019).

Institutional effectiveness acts as a coordination mechanism between the digital and green dimensions. Empirical findings show that stable regulatory frameworks and high administrative capacity accelerate the adoption of sustainable technologies and stimulate innovation ecosystems (Zahra et al., 2023). When these three elements function in coherence, they generate a competitive environment that encourages investment, enhances adaptive capacity and supports sustainable economic development.

4. Product competitiveness under the twin transition

The transformation generated by the green transition and the digital transition has a direct impact on the competitiveness of products manufactured within European value chains. Competitiveness is no longer determined solely by price or traditional production efficiency but also by the degree of innovation, environmental performance and technological capability embedded in products. Contemporary empirical research confirms that products integrating digital technology and sustainable design achieve stronger positions in global markets, higher value added and longer product life cycles (Dima et al., 2018; Martínez-Caro et al., 2020).

The following case study examines the evolution of three categories of products within the European economy, highlighting how digital capability, environmental responsibility and institutional support interact to shape competitive performance.

I. Digital Products - Software Solutions and Smart Technologies

The European software and digital technology industry has been a major example of how digital transformation has helped enhance product competitiveness. This has been evidenced by software solutions that incorporate artificial intelligence, automation, and cloud technology, which have shown continuous and significant expansion in their demand in the European Union. This has enabled companies in other European nations like Romania, Poland, and Estonia to expand their reach in the wider globe with a focus on cybersecurity software, cloud technology, and data analytics software. These sectors offer good prospects of being scalable and are shaped by an innovation mind-set that promotes competitiveness.

Empirical studies show that technology-based products experience accelerated adaptation rates, improved user experience, and rapid knowledge transfer, which cumulatively lead to enhanced market performance (Martínez-Caro et al., 2020). This can be presently seen in how Romanian software firms are adopting cutting-edge programming technology, using Agile development methodologies, and relying on automation for testing. Thus, it becomes feasible for them to minimize costs of production while increasing their quality.

Digital products provide a competitive advantage in that they can be adapted for various sectors, like smart energy, logistics, and e-government. This proves that companies that implement digital solutions enhance their productivity and integration in value chains, as proved by the Digital Economy and Society Index, as it confirms that companies that implement digital solutions are more integrated in value chains than those that do not, as stated by the European Commission in 2023.

II. Industrial Products - Electric Vehicles and Automotive Components

The automotive sector represents one of the most visible examples of how the green transition reshapes product competitiveness. Electric vehicles and their associated components (battery systems, charging modules, power electronics) have become essential for achieving climate objectives and for maintaining industrial competitiveness in the European Union.

Countries such as Germany, France and Slovakia have made significant progress in producing electric cars that meet both technological and environmental standards. The competitiveness of these products is strongly influenced by advances in energy efficiency, low emission manufacturing and digital integration in vehicle control systems. Battery management systems, autonomous driving software and smart charging interfaces have evolved into critical determinants of value added in this sector.

Research on sustainable production systems confirms that green technology investments generate higher competitiveness due to improved resource efficiency, reduced energy consumption and lower dependency on external markets (Kiefer et al., 2019). Romania, through its automotive component sector, has entered the supply chain of European electric vehicles by producing wiring systems, electronic modules and specialized metal components. Although Romania does not yet produce fully electric vehicles, local suppliers benefit from increased demand for green mobility.

However, the shift towards electric products requires substantial investment in knowledge, advanced materials and institutional support, which explains the performance gap between Western and Eastern Europe. Still, the sector illustrates how product competitiveness can evolve rapidly when firms align technological innovation with environmental requirements.

III. Green Products – Sustainable Materials and Renewable Energy Technologies

The use of green products has a significant role in the European plan for a transition to a greener economy. Reasons for this are that consumers are looking for greener alternatives and laws are being tightened with regards to environmental issues. Examples of sustainable materials are biodegradable packaging, use of recycled composites, and low-emitting building materials.

Studies on eco-innovation identify that firms adopting a green product approach enhance their robustness, optimize their use of resources, and increase their reputation with investors (Păduraru, 2023; Curteanu, 2021). Firms that produce biodegradable packaging, for instance, in Central and Eastern Europe remain relevant since their products align with environmental needs as well as meet those of huge retailers in a globally interconnected world.

Another area that witnesses a rapid increase in employment is renewable energy technology. Solar energy, heating, and small wind energy are being improved and made even more economical. Evidence suggests that a place that focuses on renewable energy witnesses higher productivity and compatibility with new industrial systems (Dima et al., 2018).

There are many more installations of photovoltaic systems in Romania, and some domestic manufacturers are producing components such as metal structures, inverters, and monitoring software. This becomes feasible with lower operating expenses, enhanced energy productivity, and conformance with European goals for sustainability.

The comparative assessment of digital, industrial and green products demonstrates that competitiveness is increasingly shaped by innovation, environmental responsibility and institutional frameworks. Digital products benefit from rapid adaptation cycles and knowledge diffusion. Industrial products such as electric vehicle components derive competitiveness from technological

sophistication and environmental performance. Green products gain advantage through sustainability credentials and rising market demand.

Together, these examples show that the twin transition is not a theoretical concept but an applied transformation that influences product design, production systems and market success. Products that integrate digital capability and environmental responsibility consistently achieve greater competitive strength within the European Union and globally.

5. Conclusions

The competitiveness of products in this Twin Transition has now become reliant on readjusting value chains in Europe and their capacity to incorporate digital and environmental tech into their manufacturing processes. There has been evidence of improved efficiency and competitiveness in sectors that incorporate innovations such as digital traceability, automations related to quality, and resource management. Digital traceability reduces material losses, enhances transparency, and also assists in maintaining continuity in their manufacturing processes, especially in a disrupted environment (Gal et al., 2019).

Innovation remains an important factor in enhanced product performance in the green and digital transition sectors. High innovation intensity is linked to superior differentiation, energy efficiency, and product lifespan. OECD evaluation findings (2024) confirm that sustained R&D expenditure remains an important factor in corporate success in technology-driven and environmentally supportive sectors. Design, prototype, and predictive AI-based maintenance helps in developing flexible, long-lasting, and efficient products, sustaining innovation as a driver.

Consumer behavior further supports these patterns. The market preference is for products that are digitally enabled, sustainable, and environmentally responsible—energy-efficient appliances, smart home solutions, and sustainable product life cycles such as recyclable and degradable materials. Evidence from markets indicates that providing consumers with product sustainability information, as well as leveraging digital in product user experience, can enhance consumer loyalty and market performance (Martínez-Caro et al., 2020).

In Romania, there are opportunities for competition where domestic capabilities intersect with requirements of transition. Automotive components, renewable energy, and software design are sectors in which Romanian companies are already part of European value chains. A factor that affects transition-related opportunities for emerging nations with a proper industrial policy, which combines goals of digital transformation and sustainability, is their reactivity to new opportunities. The National Recovery and Resilience Plan focuses on innovation, green technology, and institutions. There can be substantial progression in the competitive trajectory of Romania in this manner.

Analysis suggests that competitiveness in a rising economy is increasingly shaped by interactions among technological, environmental, and institutional factors. The transition challenge has a dual role as a structural driver in rebalancing industries as a whole, forcing companies to develop a comprehensive strategy that combines innovation, sustainability, and responsiveness. Evidence shows that those economies with a comprehensive approach for integrating technology with transformation are performing better in their productivity performance.

A country like Romania, along with other European nations finding itself in a structural transformation, will rely on its ability to effectively develop human capital, enhance institutions, and foster innovation in determining to what extent it can capitalize on the opportunities offered by the twin transformation. Product competitiveness ceases to be a matter of company-level strategies but rather becomes a determinant of a country's potential for coping with technological and environmental changes.

6. Bibliography

- [1] Borowiecki, M. et al. (2021). The impact of digitalisation on productivity: Firm-level evidence from the Netherlands. OECD Economics Department Working Papers, No. 1680. OECD Publishing. <https://doi.org/10.1787/e800ee1d-en>
- [2] Dima, A. M., Begu, L., Vasilescu, M. D., & Maassen, M. A. (2018). The Relationship between the Knowledge Economy and Global Competitiveness in the European Union. *Sustainability*, 10(6), 1706. <https://doi.org/10.3390/su10061706>
- [3] European Commission. (2023). *DESI Report 2023*.
- [4] Gal, P., et al. (2019). Digitalisation and productivity: In search of the holy grail – Firm-level empirical evidence from EU countries. OECD Economics Department Working Papers, No. 1533. OECD Publishing. <https://doi.org/10.1787/5080f4b6-en>
- [5] Kiefer, C. P., Carrillo-Hermosilla, J., & del Río, P. (2019). Drivers and barriers of eco innovation. *Sustainability*, 11(3), 643.
- [6] Martínez-Caro, E., Cegarra-Navarro, J. G., & Alfonso-Ruiz, F. J. (2020). Digital technologies and firm performance: The role of digital organisational culture. *Technological Forecasting and Social Change*, 154, 119962.
- [7] OECD. (2024). *Productivity and Competitiveness Outlook 2024*.
- [8] Păduraru, T. (2023). *Dezvoltarea afacerilor sustenabile în contextul economiei verzi prin eco-inovare*. Academia de Studii Economice a Moldovei, Chișinău.
- [9] Spulbar, L. F., Mitache, D. M., & Mitache, L. A. (2024). *Digitalization and ESG synergies: Transforming regional development through corporate actions*. Annals of the „Constantin Brâncuși” University of Târgu-Jiu, Economy Series, Issue 6/2024, Vol. II, [pp. 161-165]
- [10] World Economic Forum. (2023). *Global Competitiveness Report 2023*.