

# DIGITAL LAG OR SUSTAINABLE LEAP? STRATEGIC PATHS FOR EMERGING ECONOMIES IN THE AI AGE

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This study analyses the strategic dilemma facing emerging economies in the context of the accelerated penetration of artificial intelligence (AI): will it lead to digital dependency, or will it become a catalyst for a sustainable structural leap? In response, a mediation analytical model (of mediated and contingent dependencies) is developed that links AI readiness, institutional capacity, and the degree of ESG integration with digital competitiveness and structural transformation. The study argues that AI's direct impact on the levels of economic development of a system is unstable and partial. Its impact is expressed through the activities of institutions and is conditional on the strategic integration of sustainability principles. Two alternative models (configurations) are identified: fragmented digitalization, leading to limited added value, and coordinated AI integration, supporting increased economic complexity and long-term sustainability. The article contributes to the literature by providing a contingent analytical model for studying AI-mediated structural transformation.

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## 1 Introduction

Today, the global economy is operating in a new stage of technological transformation, marked by the accelerated introduction of artificial intelligence (AI) as a fundamental technology with widespread application. Unlike previous stages of digitalization, which focused on automation and achieving information connectivity, the current stage is associated with algorithmic autonomy, predictive modelling, and transformation of decision-making processes. Data from international sources (e.g. the Stanford AI Index, IMD, OECD) show a clear concentration of investments in AI, increased research and innovation activities, mainly in a limited circle of highly developed countries, which raises the risk of deepening global digital asymmetries (Ivanov, 2022).

The question of whether AI can support catch-up development or reinforce existing inequalities cannot be answered through a purely technological lens. Historical evidence from previous technological revolutions suggests that their economic impact depends on institutional quality, strategic coordination, and governance capacity. In this environment, developing economies find themselves in a particularly vulnerable position. On the one hand, AI creates the potential for “step-skipping” through direct integration of high-tech solutions. On the other hand, dependence on external technology providers, limited R&D capacity, human capital deficits, and weak institutional capacity can make AI a factor in deepening structural vulnerability. This outlines the main strategic challenge, the focus of this study: under what conditions does AI act as a catalyst for sustainable structural transformation, and when does it reinforce peripheral positioning in the global economy?

Existing literature typically addresses AI in three dimensions: 1) impact on productivity and innovation; 2) measurement of digital competitiveness; and 3) sustainable governance and ESG policies. However, an integrated analytical framework is lacking that simultaneously considers AI as a technology of general application and analyses the role of ESG-oriented strategies as a factor determining the long-term impact on competitiveness and structural transformation. This study positions itself precisely in this theoretical gap.

The main thesis of this study is that the impact of AI on the digital competitiveness and structural dynamics of developing economies depends on the interaction between technological readiness, institutional capacity and the degree of integration of sustainable development goals. The study is based on theoretical analysis and comparative research through secondary analysis of international indicators for AI readiness, digital competitiveness and sustainable development. Its aim is to develop a concept of an integrated model that explains the conditions under which AI acts as an accelerator for achieving sustainable economic and social development. In this context, the main research questions are:

- Under what conditions can AI help overcome structural constraints in developing economies?
- How do ESG-oriented strategies influence the long-term impact of AI on digital competitiveness?
- What is the role of institutional capacity as a bridge between technological integration and sustainable development?
- Is there a realistic possibility of achieving a “sustainable digital leap”, or will technological dependency continue to deepen?

This paper makes three specific contributions: 1) conceptualizes the notion of a “sustainable digital leap” as an alternative to dependency-driven digitalization; 2) integrates AI readiness, institutional capacity, and ESG orientation into a unified analytical framework; 3) develops a mediation model that explains how AI influences structural transformation through institutional transmission and sustainability conditions. Since the analysis is based on aggregated international indices, it does not cover sectoral and regional differences in individual economies, nor does it provide a quantitative test of the proposed causal logic. Regardless of these limitations, the developed framework offers a tool for strategic understanding of the role of AI in the long-term trajectory of emerging economies.

## **2 Theoretical Framework: AI between Dependence and Sustainable Development**

This research is based on the understanding that artificial intelligence is not just a new technological tool, but part of a broader transformation that impacts the structure of the economy, value creation models, and institutional governance

mechanisms. AI operates as a potential catalyst for catch-up development and as a factor in deepening existing asymmetries. This dual role leads to the need of integration of three theoretical perspectives: 1) digital competitiveness and structural constraints facing developing economies, 2) ESG framework as a strategic mechanism for managing technological transition, and 3) alternative development trajectories – fragmented digitalization vs. coordinated strategic integration.

## **2.1 Digital competitiveness and structural constraints**

### *Digital lag as a structural phenomenon*

The concept of “digital lag” goes beyond the classic concept of “digital divide”, which focuses on infrastructural access to the Internet and ICT. In the contemporary context, the key issue is not only the availability of technologies, but also the ability of the economy to integrate them productively into production processes, services and public governance. As van Dijk (2020) and OECD (2023) emphasize, the transformational effect of digitalization depends on the quality of use of the implemented technologies, institutional readiness and the degree of strategic coordination. Digital lag could be defined as a structural inability to transform technological investments into sustained productivity and innovation outcomes. It often leads to the reproduction of a peripheral model of participation in global value chains, limited to low-tech activities and minimal innovation autonomy (UNCTAD, 2023).

Brynjolfsson, Rock and Syverson’s (2021) analysis of the “productivity paradox” shows that large investments in digital technologies do not automatically lead to measurable productivity gains. Positive returns depend on complementary organizational changes, new business models, and skills accumulation. Digitalization therefore functions as a conditional factor of growth, the outcome of which depends on the availability of complementary institutional and organizational resources. From a macroeconomic perspective, international digital competitiveness indices (IMD, WEF) show a concentration of digital capabilities in economies with high institutional quality, an innovation ecosystem and significant investments in human capital. Developing countries lag primarily due to limited systemic integration of digital solutions into the industrial and public structure.

*Institutional capacity and technological dependence*

In the context of institutional economics, North (1990) argues that sustainable growth is a function of stable and predictable institutional rules that reduce transaction costs and encourage investment in innovation. In AI-driven economies, this principle extends to data governance, transparency, and regulation of digital markets presuppose a high degree of institutional competence.

Acemoglu and Robinson (2012) emphasize that a strong institutional base is a prerequisite for sustainable technological development, while extractive institutional structures can concentrate the benefits of innovation in limited groups. In the context of AI, this is manifested through the global concentration of computing resources, patents and digital platforms in a small number of countries and corporations. UNCTAD (2023) data show that the majority of investments in AI are directed to a few developed economies, which limits the opportunities for autonomous development of technological capacity in peripheral countries. This asymmetry creates a risk of forming a “digital dependency trap”, in which developing economies remain mainly users of foreign technologies and platforms, without the opportunity to build their own research and innovation base. Rodrik (2011) emphasizes the role of coordinated industrial policy in the process of technological catch-up. In the AI context, this requires coordinated interaction between state, business and academia, aimed at creating local capacity, rather than fragmented implementation of external solutions.

Institutional alignment creates the enabling environment, but it is organizational strategic capacity that determines whether AI translates into measurable competitive gains. In this sense, digital transformation represents the structured integration of human, informational, and organizational capital into a coherent strategic architecture that converts intangible capabilities into sustained performance outcomes (Tanushev, 2022).

*Digitalization, value added and economic complexity*

Artificial intelligence is seen as a general-purpose technology (Aghion, Antonin, & Bunel, 2023), capable of transforming multiple sectors simultaneously. Historically, such technologies generate delayed and institutional-dependent productivity effects.

Perez's (2002) theory of technological revolutions shows that new technological paradigms initially enter an environment with a clear institutional incompatibility, which requires regulatory and organizational transformation. Empirical analyses by OECD (2022) confirm that enterprises that combine investments in digital technologies with skills development and organizational reform achieve higher productivity growth than those that implement technologies as an isolated management solution. Therefore, the relationship between digitalization and added value is not linear. Automation without structural upgrading does not increase economic complexity. The World Bank (2021) emphasizes that data and digital technologies generate public value only in the presence of effective governance, transparent rules and public trust.

Digital competitiveness thus emerges as a systemic outcome of technological capability, institutional quality and value-creation capacity. Structural constraints in developing economies arise from the interaction between technological gaps and weak institutional coordination. This interdependence leads to the need to examine ESG as a strategic mechanism shaping AI-driven transformation.

## **2.2 ESG as a strategic framework for sustainable transition**

ESG principles initially emerged in the context of corporate governance as a tool for assessing non-financial risks and the sustainability of companies (Elkington, 1998) (Eccles & Strohle, 2018). With the development of global capital markets and regulatory standards, ESG has gradually transformed from a reporting framework into a broader strategic framework that influences capital allocation, investment priorities and institutional design (Friede, Busch, & Bassen, 2015) (OECD, 2022). ESG functions as a strategic coordination mechanism shaping incentives, risk management, and allocation of innovation resources.

In the context of accelerated AI transformation, this functionality is particularly important. Artificial intelligence can increase productivity and efficiency, but at the same time it also carries risks of concentration of market power, automation of labor, algorithmic discrimination and significant energy consumption (OECD, 2025) (UNESCO, 2021). Without appropriate governance mechanism, these externalities can amplify social and structural imbalances.

ESG therefore functions as a mediator in three main directions:

- 1) allocational – by directing investments towards sustainable technological solutions;
- 2) regulatory – by institutionalizing standards for transparency, accountability and data management;
- 3) legitimization – by creating public trust and social acceptability of digital transformation.

Empirical observations from global supply chains suggest that ESG frameworks frequently emerge as self-regulatory substitutes in contexts of weak or fragmented public governance, particularly in emerging economies (Boeva, 2015). Initiatives such as the OECD Principles on AI and regulatory frameworks such as the European Union’s AI Act show that AI governance is gradually being integrated into a broader logic of responsible and sustainable innovation. This does not mean that ESG automatically guarantees a balanced transition, but it does show that technological developments are increasingly being assessed through the prism of institutionalized responsibility.

#### *Integrating technological development with sustainability principles*

The theory of “creating shared value” (Porter & Kramer, 2018) argues that economic efficiency and social impact can be mutually reinforcing when strategic decisions are oriented towards creating long-term value for the system. In the AI context, technological policy must be embedded within broader development strategies. The integration of technological development and sustainability principles implies institutional coordination between industrial policy, education system, data regulations and environmental standards. The World Bank (2021) emphasizes that data generates public value only when there are clearly defined rules for access, protection and sharing, while UNDP (2022) notes that digital transformation contributes to the achievement of the Sustainable Development Goals (SDGs) only if it is integrated into national strategic frameworks.

From an analytical perspective, this means that ESG does not change the technological capability of the economy itself, but the way it is directed and structured for use. While institutional capacity determines the possibility of AI

integration, the ESG framework influences the direction of that integration – whether it will focus on short-term efficiency or on increasing economic complexity, social connectivity and accessibility, and environmental sustainability.

*"Sustainable digital leap" as institutional alignment*

The concept of a “sustainable digital leap” can be described as a process of alignment between technological innovation, institutional design and sustainability goals, in which AI is used to overcome structural constraints rather than to reproduce them. The classic theory of catch-up development (Gerschenkron, 1962) suggests that partial economic backwardness can be compensated by rapid adoption of available technologies. In the AI context, however, adoption without institutional alignment creates the risk of dependency and limited generation of added value. Perez (2002) shows that technological revolutions require new institutional alignment to move from a diffusion phase to a sustainable development phase.

In these conditions, the sustainable digital leap is not seen as a quantitative expansion of the number of AI projects, but as a qualitative transformation of the economic structure by building innovation capacity, increasing technological sophistication and strengthening social cohesion. In this framework, ESG plays the role of a mediator, bringing out the factors that lead to the integration of AI into the economy, reducing the likelihood that it will become a source of asymmetric dependence. Viewed in this way, the sustainable digital leap represents an alternative direction of development in which technological transformation is institutionally directed and strategically coordinated. This allows for an analytical distinction between superficial digitalization (limited to the implementation of technologies) and structural modernization based on synchronization between AI, institutional capacity and sustainability orientation.

### **2.3 The dual path of development: fragmented digitalization versus strategic integration**

The penetration of AI into developing economies does not follow a universal or technology-driven path. Its trajectory depends on the configuration of technological readiness, institutional capacity, and strategic alignment. Within this framework, two analytical models can be distinguished: 1) fragmented, reactive digitalization and 2) coordinated, institutionally aligned AI integration.

*Model I: Fragmented and reactive digitalization*

The first model is characterized by partial and unsynchronized implementation of AI in individual sectors or organizations. Digitalization emerges as a reactive response to external pressure (international competition, regulatory requirements or requirements of global investors) without the presence of an integrated national vision (including strategy). In such an environment, technological solutions are applied sectorally (fragmentarily), without connection with the education system, industrial policy or strategic data management. The lack of a “whole-of-government” approach (OECD, 2025) leads to limited return on public investments and a low degree of technological diffusion in the economy. The absence of synchronization between technological implementation and human capital development limits the possibility of creating internal innovation capacity. As a result, economy remains dependent on external platforms and software ecosystems, with local added value concentrated in adaptation and service, rather than in the creation and development of technologies.

Empirical observations by UNCTAD (2023) and the World Bank (2021) show that in a number of developing economies, digital technologies are used primarily to optimize existing processes, without leading to a targeted and appropriate change in the production structure. This leads to entrenchment in peripheral segments of global value chains and limited economic complexity. In the absence of ESG integration, the risks resulting from the implementation of fragmented digitalization are amplified: investments are directed towards short-term efficiency, without including structural transformation.

*Model II: Coordinated and strategically aligned AI integration*

The alternative model assumes the presence of a long-term AI strategy, integrated with the implemented industrial policy, the education system, the research infrastructure and the regulatory system. In this case, the institutional capacity acts as a mediator between technological innovation and the transformation of the economic structure (North, 1990) (Rodrik, 2011). Coordinated integration includes the development of local innovation ecosystems, investments in STEM education, data management as a strategic resource and the construction of computing infrastructure. AI is perceived and used as a horizontal infrastructure that

reorganizes production processes, public services and management practices (Aghion, Antonin, & Bunel, 2023). In this scenario, the ESG framework performs an operational function. It influences:

- the choice of investments, directing resources towards solutions with a long-term social impact;
- the regulatory system, through requirements for transparency, accountability and data protection;
- the social legitimacy of the digital transformation, which reduces the risk of institutional and public resistance.

In such a configuration, AI can contribute to increasing economic complexity, creating local technological capacity and improving the quality of public governance. However, it should be noted that coordinated integration is not automatically a guaranteed success. Insufficient administrative capacity, the lack of an adequate national development strategy or ineffective industrial policy can limit the transformative potential of AI, even in the presence of strategic documents for its implementation and use. Therefore, sustainable results depend on the real functioning of institutions, not on their formal existence.

The main distinction between the two models lies in the mode of institutionalization of AI. In fragmented systems, technological adoption reproduces existing structural constraints, whereas in coordinated frameworks, AI is integrated into broader strategies of structural modernization. This forms the basis of the analytical model, considering AI as a conditional tool, the long-term impact of which on competitiveness and structural dynamics depends on the quality of management and the degree of strategic integration.

### 3 Methodological approach

The present study applies a **conceptual-comparative approach**, combining theoretical synthesis with secondary analysis of international indicators and strategic documents. This choice reflects the complex and context-dependent nature of the relationship between AI integration, institutional capacity, ESG orientation, and digital competitiveness. Accordingly, the study develops an integrated framework

aimed at explaining the structural conditions under which different development trajectories (fragmented digitalization or coordinated strategic integration) emerge.

### **3.1 Research foundation and design**

The methodological framework is based on an interdisciplinary synthesis between: (i) the theory of technological paradigms and the need for institutional compliance in technological revolutions (Perez, 2002), (ii) institutional economics and the role of rules and organizational incentives for sustainable growth (North, 1990), (iii) the theory of inclusive institutions and the risk of concentration of the benefits of technological progress (Acemoglu & Robinson, 2012), and (iv) the literature on digital competitiveness and the systemic factors of digital leadership (IMD; OECD).

The approach used can be seen as a form of scenario modelling, within which the identified structural determinants serve as a basis for building ideal-typical configurations outlining alternative development trajectories. The conceptual analysis performs three functions:

- 1) deduces the mediating role of institutional capacity between AI readiness and economic outcomes (North, 1990);
- 2) justifies ESG orientation as a strategic moderating mechanism that directs technological integration towards sustainable outcomes (OECD, 2022) (Porter & Kramer, 2018);
- 3) formalizes the interrelationships in a model “AI – Institutional Capacity – ESG – Digital Competitiveness”, which serves as a basis for typology of scenarios.

The comparative analysis follows the logic of a structural-typological approach used in comparative political economy to identify sustainable institutional configurations (Hall & Soskice, 2001). The comparative procedure is non-econometric and configurational, relying on relative positioning and pattern identification rather than statistical inference. The procedure involves three sequential steps:

**First**, countries (or groups of countries) are ranked along three dimensions: (1) AI readiness and technological/institutional readiness; (2) digital competitiveness as a systemic outcome; (3) sustainability and governance compliance as a proxy for ESG integration. The distinction between high-income and developing economies is

based on World Bank and IMF classifications, with the aim of identifying systemic differences in the structural parameters of the digital transition.

**Second**, the compatibility and imbalances between the dimensions are analysed, i.e. whether high values on the AI dimension coincide with institutional efficiency and sustainability orientation, or configurations of “technological dynamics without institutional alignment” are observed. In this context, compatibility is interpreted as the degree of alignment between technological capacity, institutional quality, and sustainability orientation, while imbalances refer to asymmetric configurations across these dimensions. The indicators are used as signals for structural mismatches relevant to the risk of dependency or the potential for structural leapfrogging (Acemoglu & Robinson, 2012).

**Third**, based on the configurational reading, ideal-typical scenarios are formulated, corresponding to the two models from the theoretical framework: a) fragmented, reactive digitalization (high dependence on external technological ecosystems, limited institutional capacity, weak sustainable integration); b) coordinated strategic integration (institutional alignment, investments in human capital and data, sustainability orientation and regulatory accountability). These scenarios are constructed as analytical configurations derived from consistent patterns of alignment or misalignment across the examined dimensions. Qualitative analysis of strategic documents complements indicator observations and allows for an assessment of the degree of policy coordination and regulatory maturity.

### **3.2 Indicator dimensions and sources used**

The empirical grounding of the methodological framework is based on secondary data from internationally recognized indices and reports. The selection of indicators follows a structured logic aimed at capturing three distinct analytical layers: input capacities, institutional mediators, and systemic outcomes. Rather than being used for econometric estimation, the indicators serve as comparative proxies that enable the identification of structural patterns and configurational relationships across economies

*Indicators for assessing AI readiness and AI capacity*

**The Government AI Readiness Index** (Oxford Insights) is used as a proxy indicator of institutional and regulatory readiness for AI implementation in the public sector, including data infrastructure and human capital. The focus of the study is that the index captures not only the technological level, but also the degree of strategic coordination and management maturity.

**The Stanford AI Index Report** provides data on investments, scientific output, patents, start-ups and industrial deployment, which allows to assess the **real innovation activity** and concentration of AI capacity globally (Stanford Institute for Human-Centered Artificial Intelligence (HAI), 2024). The combined use of these two sources enables a distinction between **potential/readiness** and **actual innovation dynamics**, especially relevant for developing economies.

*Indicators measuring digital competitiveness as a systemic outcome*

**The IMD World Digital Competitiveness Ranking** is used as a key indicator of the systemic ability of economies to transform digital capacity into competitive advantage through components that combine knowledge, technological environment and future readiness.

Additionally, digital components of the **World Economic Forum – Global Competitiveness** (e.g. ICT adoption, innovation capability, skills) are used, as well as the **OECD Digital Economy Indicators**, which provide empirical support for the relationship between digital intensity, skills and productivity (World Economic Forum, 2019) (OECD, 2020). These sources are used in a complementary manner to enable comparative positioning and to identify persistent structural differences across economies.

*Indicators measuring ESG integration, sustainability and quality of governance*

In this article, ESG is not treated as a corporate rating, but as the degree of sustainability integration and institutionalized responsibility in national strategy. Therefore, a combination of proxy measures is used:

- **SDG Index** as an indicator of effective sustainability and compatibility between development and socio-environmental goals (Sachs, Lafortune, Fuller, & Drumm, 2023);
- **World Bank Worldwide Governance Indicators (WGI)** as a measure of institutional quality (rule of law, control of corruption, regulatory effectiveness, government efficiency), relevant to the state’s ability to manage technological transition (Acemoglu & Robinson, 2012);
- **Strategic and regulatory documents** (national AI strategies; European Commission documents, including the AI Act; OECD AI Principles, 2019; UN/UNDP/UNESCO frameworks), used to qualitatively assess coordination, regulatory maturity and institutional priorities.

### *Model logic*

Combining the indicators builds an integrative analytical framework that simultaneously assesses:

- 1) AI readiness/capacity as an input variable;
- 2) institutional capacity and governance quality as a mediator;
- 3) ESG integration as a strategic moderator;
- 4) digital competitiveness and sustainable outcome as output dimensions.

The framework allows for the identification of typological configurations, for example:

- economies with relatively high AI dynamics with low governance efficiency and limited sustainability compatibility (increased risk of dependency and social externalities);
- economies with technological intensity but weak institutional capacity (vulnerability to “locked-in” specialization);
- configurations of synergy between AI integration, institutional quality and sustainability orientation, corresponding to a scenario of coordinated strategic integration.

In this way, the indicators do not function as stand-alone statistical measures, but as interconnected elements of the methodology, which helps to distinguish a digital dependency scenario from a sustainable digital leap scenario.

Several **limitations** should be explicitly acknowledged. First, the indices used are aggregated composite measures and may mask intra-regional and sectoral differences. Second, the dynamics of AI are accelerating, and some indicators may lose explanatory power in the short term (Stanford Institute for Human-Centered Artificial Intelligence (HAI), 2024). Third, the chosen design does not provide econometric verification of causal relationships; the results should be interpreted as analytical hypotheses subject to subsequent testing using panel data, structural models or configuration methods (e.g. fsQCA). Fourth, proxy measures for ESG integration are methodologically heterogeneous, and some indicators may reflect declaratives rather than performance effectiveness (Eccles & Stroehle, 2018). Finally, a significant part of AI innovations develops in transnational corporate ecosystems, which limits the ability of nationally oriented indices to capture the full dynamics of value, data control and platforms.

Despite these limitations, the methodological approach offers a conceptually coherent and empirically sound framework for structuring the interrelationships between AI integration, institutional capacity, and sustainability orientation. In this way, the section serves a dual function: (i) systematizes the fragmented literature and indicator base; and (ii) formulates clearly defined dependencies and typologies that can be subject to future quantitative verification.

#### **4 AI as a mediator of structural transformation**

In this article, artificial intelligence is viewed as a mediator of structural transformation, whose impact on economic dynamics is indirect and operates through the restructuring of production factors, institutional incentives, and innovation ecosystems. Drawing on the logic of technological revolutions (Perez, 2002), this impact remains conditional on institutional alignment and strategic coordination. Accordingly, AI can function as a catalyst for a sustainable digital leap only in the presence of three systemic prerequisites:

- institutional capacity and strategic management;

- adequate human capital;
- access to a stable digital infrastructure.

The absence of any of these prerequisites transforms AI from a tool of modernization into a mechanism of dependency.

#### **4.1 Institutional capacity and strategic management**

Institutional capacity refers to the ability of a state to formulate, coordinate and implement long-term strategies that combine regulatory frameworks, investment incentives and industrial policy. In the AI context, this capacity becomes critical due to the horizontal nature of AI, that cuts across sectors and governance domains. As North (1990) argues, institutions fundamentally shape the structure of the economy. In an AI environment, this extends to the data governance, algorithmic accountability, competition and protection of rights. The importance of transparency and disclosure as pillars of governance has been extensively discussed in the corporate governance literature, seen as preconditions for long-term trust and sustainable performance (Zhelev, 2020). A lack of regulatory predictability reduces investment activity, while excessive or inconsistent regulation can hinder innovation(OECD, 2019) (Ebers et al., 2021).

Industrial policy plays a key role in technological catch-up (Rodrik, 2011), which outlines the need for strategic investments in research infrastructure, incentives for innovation clusters and targeted missions that guide development towards societal priorities (Mazzucato, 2013). The “triple helix” model (Etzkowitz & Leydesdorff, 2000) shows that sustainable innovations emerge from synchronized interaction between state, business and academia. Leading AI ecosystems demonstrate precisely such institutional integration (Stanford Institute for Human-Centered Artificial Intelligence (HAI), 2024) (World Economic Forum, 2024). In the absence of coordination, developing economies remain dependent on external platforms and technologies.

From an analytical perspective, institutional capacity functions as a transmission mechanism that determines whether AI contributes to structural transformation or reinforces existing constraints. Under conditions of institutional alignment, AI

supports structural modernization; in fragmented regulatory environments, it tends to reproduce dependency and limit endogenous value creation.

## **4.2 Human capital and digital skills**

Human capital determines the ability of an economy to absorb and adapt general-purpose technologies (Aghion, Antonin, & Bunel, 2023). In an AI environment, this extends beyond advanced technical expertise (e.g. machine learning, data analytics) to include managerial, regulatory, and ethical competencies necessary for integrating AI into organizational and institutional processes (OECD, 2019) (UNESCO, 2021). Economies with a high level of digital skills realize higher returns on investments in digital transformation (OECD, 2023). By contrast, limited human capital constrains endogenous innovation and increases reliance on imported technological solutions, thereby reducing value creation capacity. However, AI transformation raises the risk of polarization in the labour market. Research by Acemoglu and Restrepo (2018) and Autor (2015) shows that automation can displace routine activities and increase inequalities. In developing economies, this process can deepen structural weaknesses in the absence of retraining and social adaptation programs (World Bank, 2021).

From an analytical perspective, the impact of AI on productivity and innovation is conditional on the alignment between technology strategy and human capital development. When supported by education and social adaptation policies, AI enhances innovation capacity; in their absence, it reinforces labour market segmentation and structural vulnerability.

## **4.3 Infrastructure and technological autonomy**

AI operates on three resources: data, algorithms and computing power. Digital infrastructure is therefore not just a technical prerequisite, but a strategic component of economic autonomy. The World Development Report: Data for Better Lives (World Bank, 2021) defines data as a strategic resource whose management requires institutional mechanisms for protection and transparency. OECD (2023) emphasizes that high digital intensity of companies is linked to robust broadband infrastructure and access to cloud services.

The global concentration of cloud and AI platforms in a limited number of corporations is creating new forms of dependency (UNCTAD, 2023). For economies without their own capacity to manage data and computing resources, this means reduced control over strategic assets and limited innovation autonomy. Historically, industrial modernization required the construction of physical infrastructure; in the AI era, a similar role is taken on by digital ecosystems and data.

The conditional logic states: When infrastructure is supported by institutional governance and strategic vision, AI reinforces economic complexity; when dependent on external platforms, it deepens structural vulnerability.

#### **4.4 Strategic scenarios for emerging economies**

The accumulated theoretical and methodological analysis allows the formulation of an analytical model of the strategic paths facing emerging economies in the era of AI. Within this framework, AI is treated a conditional technological factor, whose impact on economic structure depends on the configuration of institutional capacity and sustainability integration. Accordingly, two ideal-typical outcomes can be distinguished (Hall & Soskice, 2001):

- consolidation of digital dependence;
- sustainable structural transformation.

The distinction between these outcomes does not derive from the intensity of the technological adoption, but from the alignment between three systemic dimensions: a) AI readiness and integration (**A**); b) institutional capacity and strategic coordination (**I**); c) sustainability integration / ESG orientation (**S**).

##### *Scenario I: Dependency configuration: digitalization without structural leap*

This scenario assumes an increasing level of AI deployment, but with limited institutional capacity and weak strategic integration. Technological progress is largely based on externally developed platforms, cloud services and algorithmic solutions controlled by global technology ecosystems. As UNCTAD (2023) highlights, the concentration of AI infrastructure and computing capacity creates an asymmetric

environment in which developing economies remain predominantly users rather than creators of innovation.

In this scenario, AI is primarily applied to the automation and optimization of existing processes, without significant changes in the production structure. The added value resulting from the development of models, data and intellectual property is accumulated outside the national economy. According to Perez (2002), technological adoption without institutional alignment leads to partial modernization, without structural transformation, a dynamic consistent with limited economic complexity (Hausmann & Hidalgo, 2011).

In this configuration, ESG policies tend to function in a formal or compliance-driven manner, without integration into industrial strategy. As a result, digitalization can deepen existing dependencies, transforming them from industrial to algorithmic. This creates a state of dependency-driven digitalization, in which technological dynamics do not fundamentally change the position of the economy in the global hierarchy of value.

*Scenario II: Synergy Configuration: AI as a Mediator of Sustainable Structural Transformation*

The second scenario assumes a strategic alignment between AI integration, institutional capacity, and sustainability orientation. Here, AI functions as an enabling infrastructure for diversification and increased economic complexity.

Sustainable innovation growth, according to Aghion et al. (2023), requires a combination of technological dynamism and institutional stability. The institutions involved (North, 1990) (Acemoglu & Robinson, 2012) provide predictability, protection of rights and incentives for long-term investment. When AI integration is supported by a mission-oriented industrial policy (Mazzucato, 2013) and coordination between the state, business and academia, technological potential is transformed into a systemic competitive advantage. In this configuration, ESG orientation functions as a strategic filter and corrective. Rather than being an external normative tool, it directs investments towards sectors with high social returns – smart energy systems, digital healthcare, sustainable transport. According to the logic of shared value (Porter & Kramer, 2018), economic efficiency and social sustainability reinforce each other. Evidence from EU-based listed companies

suggests that sustainability regulation affects not only compliance structures but also the internal configuration of business models, including supplier relationships, value chain activities and capital allocation patterns (Boeva, 2024).

*Formalizing the strategic configuration*

To make the proposed model analytically operational, the interrelationships between the main constructs can be represented through a structural specification. In the context, **A** denotes the **degree of AI readiness and integration**, **I** – **institutional capacity**, **S** – **sustainable (ESG) integration**, **D** – **digital competitiveness**, and **Y** – **sustainable structural transformation**. Within the model, AI affects transformation indirectly through institutional mediation and competitiveness dynamics. This can be formalized as follows (equation 1):

$$D = \beta_0 + \beta_1 A + \beta_2 (A * I) + \varepsilon \quad (1)$$

In this case, the effect of AI on digital competitiveness is dependent on institutional capacity. At low levels of *I*, the impact of *A* on *D* remains limited or unstable – in line with the technological complementarity thesis (Brynjolfsson, Rock, & Syverson, 2021), according to which technologies of general application require accompanying institutional and organizational changes.

In turn, sustainable structural transformation depends on the interaction between digital competitiveness and the degree of sustainable integration (equation 2):

$$Y = \delta_0 + \delta_1 D + \delta_2 S + \delta_3 (D * S) + \varepsilon \quad (2)$$

A positive coefficient  $\delta_3$  means that **digital competitiveness becomes a sustainable structural outcome only in the presence of a strategically integrated ESG orientation**. Thus, the impact of AI is both mediated by institutional capacity and conditional on the sustainability framework.

Conceptually, strategic pathways can be further described through threshold logic. Sustainable transformation is possible with both high values of institutional capacity ( $I \geq \tau_I$ ) and integration of sustainable development principles ( $S \geq \tau_S$ ), with a sufficient level of AI readiness. If any of these conditions is not met, technological

integration remains partial and may reproduce structural constraints. This leads to an analytical matrix of configurations (Table 1):

**Table 1: Matrix of configurations between level of institutional capacity and level of ESG integration**

Institutional capacity	ESG integration	Expected effect of AI
Low	Low	Digital dependency
High	Low	Modernization without sustainability
Low	High	Regulatory ambition without capacity
High	High	Sustainable structural transformation

Source: Author’s elaboration

Thus, the proposed model represents an analytical framework of mediated and contingent dependencies in AI-mediated transformation. Its theoretical contribution consists in demonstrating a double conditionality: first, institutional, since AI generates systemic competitiveness only with sufficient institutional capacity; and second, along the lines of sustainability, since digital competitiveness becomes a sustainable structural transformation only with an integrated ESG orientation. The model demonstrates that AI’s impact is not determined by access alone, but by the configuration of institutional and sustainability conditions.

## 5 Discussion

The proposed model (AI readiness → digital competitiveness → sustainable structural transformation, given institutional stability and resilience) allows for a transition from a theoretical framework to specific political and economic conclusions. The key implication is that AI should not be treated as an autonomous technological goal, but as a component of a broader strategy for institutional alignment and structural renewal. The difference between technological adaptation and structural transformation is manifested in the ability of the state to transform technological potential into systemic competitiveness, social security and long-term sustainability.

First, the model emphasizes the role of institutional architecture as a transmission mechanism of technological effect. Institutional capacity is an active mediator through which AI investments are transformed into competitive advantage (North, 1990). Under conditions of fragmented coordination or limited administrative

capacity, technological initiatives remain isolated and short-term. In the AI context, this includes building coherent frameworks for data governance, algorithmic accountability and competition policy towards digital platforms (OECD, 2019) (UNESCO, 2021). The transition required is from deployment incentives to institutionalized coordination and regulatory capacity. Only with such institutional consolidation can AI policy go beyond pilot projects and become an instrument of structural modernization.

Second, the integration of sustainability should be seen as a guiding principle, not a secondary element of digital strategy. General-purpose technologies can accelerate productivity, but without social and environmental mechanisms, the effect is often asymmetric and politically unstable (Aghion, Antonin, & Bunel, 2023). The literature outlines risks of labour polarization (Autor, 2015) (Acemoglu & Restrepo, 2018), regional concentration of digital benefits (OECD, 2025), increasing energy intensity in the absence of green infrastructure, and concentration of market power (UNCTAD, 2023). The implication is a shift toward ESG-by-design, embedding sustainability criteria directly into strategic planning and investment decisions. In this sense, ESG does not function as a moral corrective, but as a strategic filter that ensures the public legitimacy and long-term stability of the digital transformation.

Third, the logic of the model assumes an active but not directive role of the state as the architect of the market. When the outcome depends on coordination and institutional transmission, the public sector inevitably participates in building the innovation ecosystem, sharing risk and creating conditions for market formation (Rodrik, 2011) (Mazzucato, 2013). For developing economies, this means choosing priority sectors (niches) with the potential to increase economic efficiency (Hausmann & Hidalgo, 2011), using public procurement as a tool to create demand for ethical and reliable AI solutions, investing in data and computing infrastructure, and promoting public-private partnerships. The objective is not isolation, but strategic positioning within global value networks.

Fourth, social transition is an integral part of a sustainable AI strategy. Labor market restructuring increases the risk of displacement and segmentation, particularly in economies with high shares of routine employment. Without adaptive social mechanisms, declining trust and rising instability can undermine digital transformation (World Bank, 2021). Therefore, mass retraining programs,

institutionalized lifelong learning, adapted social protection systems, and regional policies for digital convergence are not secondary measures, but conditions for sustainability. Social policy in this context is not reactive, but a component of strategic planning.

Finally, geo-economic dimensions complement the model, as the global AI ecosystem is concentrated in terms of patents, platforms and computing resources (Stanford Institute for Human-Centered Artificial Intelligence (HAI), 2024), raising the question of control over critical dependencies. Technological sovereignty does not mean isolation, but the ability to strategically choose and manage interdependencies – through diversification of partnerships, regional coordination and a minimum national capacity to manage critical digital infrastructure.

This research shows that emerging economies face a strategic bifurcation between digitalization that reproduces dependency and AI-mediated sustainable structural transformation. The determining factor is institutional and strategic, not technological: the quality of governance transmission and the degree of ESG integration determine whether AI will remain a tool for partial optimization or function as a catalyst for sustainable structural renewal. In this sense, the sustainable digital leap is not a technological phenomenon, but a managerial choice that requires coordination between industrial policy, education, social adaptation, regulation and geo-economic positioning.

## 6 Conclusion

This paper focuses on the strategic dilemma of whether accelerated AI transformation will deepen the existing digital lag of developing economies or can become a mechanism for sustainable structural leapfrogging. The main conclusion is that AI is neither an autonomous engine of catch-up nor an inevitable source of dependency, but a conditional technological accelerator.

The theoretical contribution of the article lies in the **development and formalization of a mediation model** that links AI readiness, institutional capacity, and ESG integration with digital competitiveness and structural transformation. The model demonstrates that **AI effects are non-linear and mediated by institutional capacity**. A sustainable **digital leap emerges only under a specific configuration**

of technological readiness, institutional quality and ESG integration. The study **contributes by integrating** these dimensions into a unified analytical framework.

The proposed scenario typology (digital dependency vs. sustainable structural leap) can be used as a conceptual tool for comparative analysis of economies in the global digital system. It highlights that fragmented digitalization based on external technologies has limited transformative capacity. Conversely, an integrated industrial policy, supported by investments in human capital, computing infrastructure and institutional strengthening, increases the likelihood that AI will become a source of increased economic complexity and long-term sustainability.

The practical implications are consistent with this logic. AI strategies in emerging economies should not be isolated technological documents, but part of broader institutional and industrial reform. Policies should simultaneously strengthen data governance, modernize education systems, provide social adaptation mechanisms, and integrate ESG criteria into the investment planning process. In this context, technological sovereignty does not mean isolation, but the ability to make strategic choices, manage dependencies, and control critical resources of the digital economy. The study also outlines directions for future empirical validation of the model. These include panel models, mediation and interaction analysis, and configurational approaches such as fsQCA. Ultimately, the dilemma facing emerging economies in the AI era is not a question of technological access, but of managerial maturity. Digital lag and sustainable structural leap represent alternative outcomes shaped by institutional configurations rather than predetermined trajectories.

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