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Digital Sovereignty and the Reconfiguration of Comparative, Advantage: Toward a New Economics of Global Value

Elman Azizov*

Ph.D. in Economics, Azerbaijan State University of Economics, Baku, Azerbaijan,MPA, John Jay College of Criminal Justice, New York, USA,Member, Pi Alpha Alpha Global Honor Society for Public Affairs and Administration

Email: azizovelman@gmail.com

Abstract

The global economy is moving into a stage where data and algorithms shape production as decisively as land, labor, or capital. Earlier theories of trade—beginning with Ricardo's idea of comparative advantage and the Heckscher–Ohlin factor-endowment model—were built on the assumption that countries prosper by specializing according to natural resources and industrial skills. In the digital era, however, advantage increasingly depends on who manages the main channels of information: data ownership, cloud systems, and algorithmic design. This study proposes a framework for digital comparative advantage that links the unequal distribution of data and digital capacity to new global disparities. It presents digital sovereignty—the ability of a state to govern and gain value from its data networks—as a key influence on national performance. The paper concludes that a fairer global order will require redefining sovereignty not only as a political concept but also as an economic and informational one, extending classical trade thinking to the realities of artificial intelligence.

Keywords: digital sovereignty; comparative advantage; algorithmic capital; global value chains; data governance.

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* *Corresponding author.*

1.Introduction

During the past two centuries, international trade has shifted from the movement of tangible goods to the circulation of ideas, knowledge, and digital services. Classical economists such as Adam Smith and David Ricardo described prosperity as the outcome of specialization based on relative efficiency. Smith's theory of absolute advantage and Ricardo's principle of comparative advantage laid the intellectual base for global markets and open exchange [1,2]. Today, that foundation is being reshaped. The familiar inputs of capital, labor, and technology can no longer account for differences in productivity or competitiveness. A new factor has appeared—the ability to control digital infrastructure and convert information into value. Baldwin [20] describes this shift as a "second unbundling," in which the flow of data and ideas, rather than goods, drives global interaction.

Countries that host major platforms or manage large-scale cloud networks exercise economic power disproportionate to their share of global GDP. Developing economies often remain digital consumers—supplying data but lacking the capacity to transform it into higher-value knowledge. Amid these changes, the notion of digital sovereignty has gained importance. In classical terms, advantage arose from labor productivity; in the digital economy, it stems from the ability to learn from and govern data [11]. The paper examines these dynamics and outlines how digital sovereignty may redefine comparative advantage in the twenty-first century.

2. Theoretical Background

Theories of international trade have changed in pace with the evolution of the global economy. Early writers such as Adam Smith and David Ricardo described a world of physical production and limited knowledge flows. Smith's idea of absolute advantage grew from the division of labor and specialization, while Ricardo demonstrated that every nation could benefit from exchange if it focused on the goods it produced most efficiently [1,2]. Their models assumed that information and technology spread freely and that competition naturally balanced outcomes among countries.

In the early twentieth century, trade theory was expanded by Eli Heckscher and Bertil Ohlin, who argued that the pattern of trade depends on factor endowments. Countries would export goods that used their most abundant resources—labor, capital, or land—more intensively [3]. Yet the model rested on conditions that rarely hold today: friction-free technology transfer, perfect market information, and constant returns to scale. The information age has exposed these limitations. Unlike machines or buildings, information can be reused indefinitely, and its worth grows as it circulates. Arrow [4] and Romer [5] showed that knowledge generates positive spillovers and behaves unlike other forms of capital. Its non-rival and cumulative nature makes innovation self- reinforcing, concentrating advantages where knowledge is already abundant. Later developments—known as the new trade and new growth theories—made these mechanisms explicit. Krugman [6] explained how increasing returns and imperfect competition can lock in advantage for early innovators, while Romer [7] and Grossman and Helpman [8] placed learning and innovation at the center of economic expansion. Even these modern frameworks often treated knowledge as an open, public resource rather than a privately owned and governed asset. The emergence of digital platforms in the twenty-first century has changed this picture.

Massive datasets, proprietary algorithms, and platform-driven ecosystems have turned information itself into a form of capital. Once a digital platform reaches scale, network effects allow it to dominate markets, illustrating a new kind of monopoly rooted in data control [9,10]. This reality challenges the assumption that information automatically diffuses; instead, it accumulates within a few firms and economies. To understand these dynamics, economists must move beyond the traditional factors of land, labor, and capital and consider information endowments—the volume, diversity, and controllability of data that a nation can generate and govern. Comparative advantage in the digital age arises from differences in informational capacity and institutional strength rather than from natural resources alone. Alongside physical and human capital, algorithmic capability—the ability to transform raw data into useful predictions—has become a decisive determinant of competitiveness.

3. Engagement with Previous Studies

A growing body of research has examined how the digital transformation reshapes competition between countries. Kenney and Zysman, for example, argue that digital platforms have reorganized entire industries by concentrating data flows and placing platform owners at the center of economic coordination [11]. Srnicek extends this view by showing how platform firms turn data accumulation into a form of monopoly power that differs from earlier industrial-scale dominance [10]. UNCTAD's reports further illustrate this trend, noting that most digital value extraction occurs in economies that already possess advanced technical and institutional capabilities [9]. Scholars in development economics have raised related concerns. Reinert [14] and Rodrik [13] suggest that late-developing countries historically faced barriers when trying to move up global value chains; the rise of data-driven production has made those barriers even more pronounced. Zuboff's analysis of surveillance capitalism adds another dimension by explaining how user-generated data become privately extracted resources, often leaving countries and individuals with little control over the information they produce [12].

This study draws on these strands of literature but takes a different step by introducing the idea of algorithmic capital as a central driver of contemporary comparative advantage. In doing so, the paper connects institutional capacity—particularly the governance of data and digital infrastructure—to the widening informational asymmetries visible in the global economy.

4. Conceptual Framework: Digital Sovereignty

Digital sovereignty can be understood as a state's ability to shape, regulate, and benefit from the digital systems operating within its borders. While the term is used in various ways, it generally reflects a country's control over the infrastructures and rules that determine how data are created, stored, processed, and monetized.

Three elements are especially important:

- Infrastructure autonomy: the extent to which a country maintains domestic or trusted control over data centers, cloud facilities, and the physical networks that support digital activity.
- Regulatory authority: the legal and institutional frameworks that govern data access, privacy, sharing, and commercial use. These rules influence how much of the value generated from domestic data remains within the national economy.

- Algorithmic capability: the technical and analytical capacity needed to transform raw data into actionable knowledge or digital products.

Countries that possess these foundations tend to capture greater informational rents and exercise more influence in global digital markets. Those without them often depend on foreign platforms or external infrastructure providers, which can limit their ability to shape economic outcomes or protect national interests [10,12,13].

5. Theoretical Model: Reconfiguration of Comparative Advantage

Classical trade theory describes specialization as the outcome of relative productivity differences. Ricardo's well-known two-country framework shows that countries gain by producing goods for which their opportunity cost is lowest [2]. In the contemporary digital economy, however, relative productivity is no longer driven only by labor quality or technological diffusion. A growing share of productivity now depends on how effectively a nation organizes, governs, and applies its information systems. To reflect this shift, the model introduces algorithmic capital (A) as a distinct factor of production that captures a country's capacity to process data, operate digital infrastructure, and enforce data-governance rules.

Consider two countries—D (digitally advanced) and L (digitally lagging). Both produce a data-intensive good (X) and a conventional good (Y). Their production functions can be written as:

Xi=AiαTiβKiγLiδ,Yi=KiθLiϕ,X_i = A_i^{\alpha} T_i^{\beta} K_i^{\gamma} L_i^{\delta}, \qquad Y_i =

K_i^{\theta} L_i^{\phi},Xi=AiαTiβKiγLiδ,Yi=KiθLiϕ,

where i∈{D,L}i \in \{D, L\}i∈{D,L}, and each exponent represents the elasticity of output with respect to the corresponding input.

In the classical Ricardian setting, comparative advantage emerges mainly from differences in TiT_iTi (technology) or from the capital–labor ratio (K/LK/LK/L). In the digital era, however, disparities in algorithmic capital AiA_iAi dominate. A digitally advanced country with deeper data resources and stronger analytic capability gains a structuralproductivity edge. Relative efficiency in producing the digital good becomes:

XD/LDXL/LL=(ADAL)α(TDTL)β.\frac{X_D / L_D}{X_L / L_L} = \left(\frac{A_D}{A_L} \right)^{\alpha} \left(\frac{T_D}{T_L} \right)^{\beta}.XL/LLXD/LD=(ALAD)α(TLTD)β.

If AD>ALA_D > A_LAD>AL and TD≈TLT_D \approx T_LTD≈TL, the gap in AAA alone is sufficient to sustain long-term advantage. Because algorithmic capital generates network externalities and increasing returns, small differences accumulate over time—an outcome consistent with the insights of Krugman and Romer Reference [6,7].

The accumulation of algorithmic capital can be represented as:

A˙i=ηiAi+μiDi,\dot{A}_i = \eta_i A_i + \mu_i D_i,A˙i=ηiAi+μiDi,

where ηi\eta_iηi captures internal learning and capability development, and μiDi\mu_i D_iμiDi reflects external inflows of data. When both ηD>ηL\eta_D > \eta_LηD>ηL and μD>μL\mu_D > \mu_LμD>μL , divergence grows steadily, following a path-dependent trajectory similar to those described in new-growth theory Reference [8].

Digital rents generated by algorithmic capital are defined as:

Ri=PX[f(Ai,Ti,Ki,Li)−f(0,Ti,Ki,Li)],R_i = P_X [f(A_i, T_i, K_i, L_i) - f(0, T_i, K_i,

L_i)],Ri=PX[f(Ai,Ti,Ki,Li)−f(0,Ti,Ki,Li)],

where RiR_iRi measures the additional value created by the presence of algorithmic capability. Because digital goods have very low marginal cost and can scale at close to zero cost, even modest advantages in AAA translate into substantial income gaps [9,10].

These mechanisms imply that comparative advantage in the digital age becomes endogenous. It is no longer pinned primarily to natural resource endowments or inherited factor proportions but is instead shaped by institutional and technological capacity. In this setting, international trade does not necessarily promote convergence. Informational advantages accumulate rather than diffuse [11,12], allowing leading countries to consolidate their position while others risk falling into persistent digital dependency.

The policy implication is that narrowing digital gaps requires deliberate efforts to expand access to algorithmic capital. Investments in digital education, open-data platforms, and cross-border cooperation can help countries build the informational foundations needed to participate more equitably in global value chains. Without such efforts, globalization risks reinforcing—rather than reducing—existing inequalities.

6. Empirical Illustration

Although the idea of digital sovereignty is still emerging in the economic literature, existing evidence already shows clear differences among countries in their data capacity, digital infrastructure, and regulatory strength. These disparities strongly influence how nations engage in international trade. The patterns that follow reinforce the argument that algorithmic capital and institutional capability are becoming central components of comparative advantage.

6.1. Digital Infrastructure and Concentration

Global digital infrastructure is far from evenly distributed. Data from the International Telecommunication Union (ITU) and the OECD indicate that close to 70 percent of the world's data centers are located in North America and Western Europe, with most of the remaining capacity found in East Asia—primarily China, Japan, and South Korea [8,15,25]. In addition to this geographic concentration, five multinational firms—Amazon, Microsoft, Google, Alibaba, and Tencent—dominate global cloud services. For many developing economies, this means that even routine data storage must occur outside their borders. Reliance on foreign providers creates a new form of

economic dependence that resembles earlier vulnerabilities tied to industrial capital or foreign technology [9,10].

6.2. Algorithmic Innovation and Intellectual Property

A similar pattern appears in the domain of innovation. According to the World Intellectual Property Organization (WIPO), more than 90 percent of artificial-intelligence-related patents originate in just ten economies, led by the United States, China, Japan, Germany, and South Korea [24]. OECD data also show that wealthier countries devote between three and four percent of GDP to digital research and development, while most developing regions invest only a fraction of that amount [15]. These imbalances reflect the feedback loops highlighted in new growth theory: the more a country innovates and learns, the greater its future capacity to innovate again [7,8].

6.3. Regulatory Capacity and Data Governance

Institutional variation further shapes digital competitiveness. Regulatory frameworks such as the European Union's General Data Protection Regulation (GDPR) and China's Data Security Law have already influenced global norms by determining how firms handle data and under what conditions they may operate across borders Reference [13,18]. Countries lacking similar regulatory coherence often find themselves exporting raw data while importing expensive digital services built on that data [12]. Global indicators—including the UN E-Government Development Index and the ITU Global Cybersecurity Index—show a strong connection between governance quality and digital performance [23,25].

6.4. Digital Trade and Value Capture

Trade statistics reveal the same structural disparities. The World Trade Organization estimates that cross-border digital trade—which includes e-commerce, cloud computing, and digital content—surpassed five trillion U.S. dollars in 2023 and has been growing nearly three times faster than trade in physical goods [17]. Yet most of this income flows to firms based in advanced economies. While developing regions generate enormous amounts of user data, they capture only a small share of the resulting value. OECD analyses show that more than 60 percent of data generated by firms in the United States and Europe is stored domestically, compared with less than 15 percent in Sub-Saharan Africa and Latin America [15].

Summary of Patterns

Across all indicators, several trends recur:

- Digital infrastructure and innovation are heavily concentrated in a small number of economies.
- Informational asymmetries are widening, contributing to persistent differences in productivity and income.
- Stronger data governance enables countries to internalize more digital value, reinforcing the link between institutions and competitiveness.

Taken together, these observations support the study's theoretical claim that the basis of comparative advantage

has shifted. Competing successfully in today's global economy depends less on cheap labor or natural resources and far more on a country's ability to collect, protect, analyze, and transform information into productive knowledge.

7. Discussion

The empirical patterns outlined above reinforce the central argument of this paper: in the digital era, competitive advantage is shaped less by traditional cost efficiency and far more by control over information. The ability to regulate, analyze, and meaningfully apply data—what this study refers to as digital sovereignty—now plays a

decisive role in shaping how countries integrate into the global economy and how the gains from that integration are distributed. These developments carry important implications for economic theory, policy design, and debates on global equity.

7.1 From Cost Efficiency to Informational Power

Traditional models of international trade assume that countries specialize according to relative costs and that competitive markets ensure mutual gains [2,3]. When information becomes the key input, however, cost differences no longer fully explain patterns of specialization. Countries and firms that dominate data networks and algorithmic systems set standards, determine access, and capture a disproportionate share of value created across global value chains [9,10]. As learning and scale effects accumulate, these advantages tend to strengthen over time [6,7]. Instead of narrowing disparities, digital globalization often widens them.

7.2. Digital Dependency and Global Inequality

The dynamics of dependency familiar from earlier industrial periods now reappear in digital form. Countries without robust data infrastructures or analytic capacity increasingly supply raw information to foreign platforms while retaining little of the value generated from it [9,12]. Evidence from UNCTAD and the OECD shows that just ten economies produce more than ninety percent of AI-related patents and capture nearly four-fifths of global digital- trade revenues [9,15]. These patterns suggest that technological capability—rather than market openness alone—determines who benefits most from global integration.

7.3. Institutions and Policy Responses

Institutions are central to mediating these inequalities. Regulatory frameworks such as the General Data Protection Regulation (GDPR) in the European Union or China's Data Security Law demonstrate how coherent rules can themselves become sources of digital competitiveness [13,18]. Effective governance promotes trust, attracts investment, and helps ensure that data-driven value remains within the domestic economy. For many developing countries, however, building such institutional capacity is challenging. Policies that expand broadband access, promote digital literacy, and strengthen regional coordination offer meaningful starting points [15,16]. At the same time, digital sovereignty should not be mistaken for isolation. Excessively rigid data-localization requirements may hinder innovation and splinter global networks. The challenge is to balance national control

with international connectivity. International cooperation—through the World Trade Organization, United Nations agencies, or regional blocs—could help harmonize standards and reduce the risk of regulatory fragmentation [17,19].

7.4. Implications for Economic Theory

The rise of digital sovereignty challenges long-standing assumptions within economics. Technology can no longer be treated as an exogenous factor that diffuses freely across borders; rather, it is embedded within social and institutional structures that determine who can use it and under what conditions [5,8]. Information-based production generates increasing returns, so initial advantages often intensify over time instead of diminishing [6], Reference [7]. Consequently, comparative advantage now hinges on governance quality and institutional strength as much as on resource endowments [13,14]. Trade theory must therefore incorporate learning processes, institutional capacity, and informational asymmetry into its core assumptions.

7.5. Toward a More Inclusive Digital Globalization

Building a fairer global digital economy will require cooperative strategies. Shared infrastructure initiatives, open-source tools, and transparent data-governance models can help reduce inequalities [17,19]. Regional partnerships among developing economies—including joint data repositories or collective bargaining arrangements—may also strengthen negotiating power in digital markets.

Seen this way, digital sovereignty is not a withdrawal from globalization. Rather, it provides the institutional foundation needed for meaningful and equitable participation in global networks. When governments manage informational resources effectively, global openness fosters mutual interdependence rather than one-sided dependency. The broader task for policymakers is to ensure that digital progress contributes to inclusive development instead of reproducing or deepening structural divides.

8.Conclusion

This study has argued that classical views of comparative advantage—rooted in labor, capital, and technology—no longer offer an adequate explanation of global trade dynamics. In a digital economy, competitiveness increasingly depends on who controls data, algorithms, and the infrastructures through which information flows. Digital sovereignty, defined as the ability to govern and benefit from these informational resources, now plays a central role in determining national economic performance [9,13]. By incorporating algorithmic capital into the production framework, the paper reframes comparative advantage as an outcome of institutional and informational strength rather than purely physical endowments. Countries that invest in digital infrastructure, data governance, and analytic capacity generate increasing informational returns, mirroring the mechanisms described in new growth theory [7,8]. Nations lacking these foundations risk becoming dependent on external digital powers, exporting low-value data while importing high-value digital intelligence [12].

The uneven diffusion of data and technology has shifted globalization away from convergence and toward greater asymmetry. Benefits increasingly concentrate in a small number of advanced economies [10,11]. Addressing these

disparities requires strengthening domestic institutions, expanding digital skills, and improving participation in digital value chains. From a policy perspective, inclusive digital globalization depends on combining openness with robust governance. Initiatives such as the European Union's data strategy and coordinated efforts within the World Trade Organization illustrate how shared frameworks can help balance sovereignty with cross-border integration [17,18]. Ultimately, the idea of comparative advantage must evolve—from efficient use of physical inputs toward fair and responsible governance of information. If the industrial age centered economic power on control of energy, the digital age centers it on control of information. The challenge ahead for economists and policymakers is to build systems that channel this new form of power toward shared prosperity rather than deepening existing divides.

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References

[1] A. Smith. An Inquiry into the Nature and Causes of the Wealth of Nations. London: W. Strahan and T. Cadell, 1776.

[2] D. Ricardo. Principles of Political Economy and Taxation. London: John Murray, 1817.

[3] E. Heckscher and B. Ohlin. Heckscher–Ohlin Trade Theory. Cambridge, MA: MIT Press, 1991 (original works 1919–1933).

[4] K. Arrow. "Economic welfare and the allocation of resources for invention." In The Rate and Direction of

Inventive Activity: Economic and Social Factors. Princeton, NJ: Princeton University Press, 1962.

[5] P. Romer. "Endogenous technological change." Journal of Political Economy, vol. 98, no. 5, pp. 71–102, 1990.

[6] P. Krugman. "Increasing returns, imperfect competition, and the positive theory of international trade." Journal of International Economics, vol. 9, no. 4, pp. 469–479, 1981.

[7] P. Romer. "The origins of endogenous growth." Journal of Economic Perspectives, vol. 8, no. 1, pp. 3–22, 1994.

[8] G. Grossman and E. Helpman. Innovation and Growth in the Global Economy. Cambridge, MA: MIT Press,

1991.

[9] UNCTAD. Digital Economy Report 2021: Cross-border Data Flows and Development—For Whom the Data

Flow. Geneva: United Nations, 2021.

[10] N. Srnicek. Platform Capitalism. Cambridge, UK: Polity Press, 2017.

[11] M. Kenney and J. Zysman. "The rise of the platform economy." Issues in Science and Technology, vol. 32, no. 3, pp. 61–69, 2016.

[12] S. Zuboff. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. New York: PublicAffairs, 2019.

[13] D. Rodrik. "Industrial policy for the twenty-first century." CEPR Discussion Paper, no. 4767. London: Centre for Economic Policy Research, 2004.

[14] E. S. Reinert. How Rich Countries Got Rich… and Why Poor Countries Stay Poor. London: Constable, 2007.

[15] OECD. Digital Economy Outlook 2020. Paris: OECD Publishing, 2020.

[16] IMF. World Economic Outlook: Technology and the Global Economy. Washington, D.C.: International

Monetary Fund, 2021.

[17] WTO. World Trade Report 2022: Digital Trade for Development. Geneva: World Trade Organization, 2022.

[18] European Commission. A European Strategy for Data. Brussels: European Union, 2020. [19] World Bank.

World Development Report 2021: Data for Better Lives. Washington, D.C.: World Bank, 2021.

[20] R. Baldwin. The Great Convergence: Information Technology and the New Globalization. Cambridge, MA:

Harvard University Press, 2016.

[21] J. E. Stiglitz. "Information and the change in the paradigm in economics." American Economic Review, vol. 92, no. 3, pp. 460–501, 2022.

[22] C. Freeman and L. Soete. The Economics of Industrial Innovation. Cambridge, MA: MIT Press, 1997.

[23] OECD. Global Cybersecurity Index. Paris: OECD Publishing, 2022.

[24] World Intellectual Property Organization (WIPO). World Intellectual Property Indicators 2023. Geneva: WIPO, 2023.

[25] International Telecommunication Union (ITU). Measuring Digital Development: Facts and Figures 2022.

Geneva: ITU, 2022