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Colourful Disruptions: Mapping the Multifactorial Landscape of International Biopolitics[1]

Abstract

RESEARCH OBJECTIVE: The research aims to explore the evolution and multifactorial determinants of international biopolitics, emphasizing how global governance shapes biological life across borders.

THE RESEARCH PROBLEMS AND METHODS: The study investigates international biopolitics as governance increasingly transitions from national to supranational entities, impacting health, population management, and biological well-being. It employs a mixed-methods approach, integrating systematic literature reviews, comparative policy analyses, and quantitative statistical modelling, including indices measuring biopolitical intensity and technological capabilities.

THE PROCESS OF ARGUMENTATION: Initially, the article contextualizes biopolitics historically through Foucauldian theory, advancing towards a contemporary understanding shaped by globalization and international collaboration. The argument introduces a novel conceptual framework termed „Mutating Colourful Swans," categorizing disruptive global phenomena – environmental crises (Green), conflicts (Red), migrations (Yellow), and technological advancements (Blue) – to systematically analyse their biopolitical impacts.

RESEARCH RESULTS: Empirical findings suggest technologically advanced nations demonstrate more intensive biopolitical practices, with technology

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accounting for approximately 60% of cross-national variation. Further regression analyses reveal international biopolitical governance is collectively influenced by economic, socio-demographic, political, technological, and environmental determinants, though no single factor is dominant.

CONCLUSIONS, INNOVATION, AND RECOMMENDATIONS: The study concludes international biopolitics emerges from the synergistic interaction of multiple determinants, highlighting the need for adaptable governance frameworks. The innovative „Mutating Colourful Swans" model serves as a practical analytical tool for anticipating and managing future biopolitical disruptions. The authors recommend interdisciplinary collaboration, enhancement of real-time biosurveillance networks, improvement of biopolitical quantitative metrics, and employment of scenario-based foresight methods to strengthen global governance responses to emerging biopolitical challenges.

Keywords:
international biopolitics, Foucauldian analysis, multifactorial analysis, mutating colourful swans

1. INTRODUCTION

The Swedish political scientist R. Kjellén was the first scholar to employ the concept of biopolitics (Kjellén & Sandmeier, 1924). He advocated for the conceptualization of the state as a "vital organism" or a "living entity". In a broader context, the concept of biopolitics emerged in academic discourse during the 1970s through the work of French philosopher M. Foucault (Foucault, 2008). His research examined the utilization of biopolitics as an instrument of social and political engineering within the framework of human life regulation and governance by authorities. Foucault explicitly recognized the interconnections between biopolitics and biopower as constituent elements in capitalist development, particularly regarding population control mechanisms (Foucault, 1990). Over time, this terminology evolved from classical forms of bodily surveillance within specific societies (alternatively described as aspects of biopower or life politics) toward contemporary mechanisms regulating social existence within the context of globalization processes, thus becoming an amalgamation of political, medical, legal, philosophical, technological, and economic dimensions.

This article attempts to establish a conceptual framework for addressing biopolitics from an international perspective, followed by an identification of factors currently influencing international biopolitics and an indication of processes that may significantly impact international biopolitics in the future. Additionally, the author's original concept of "mutating colourful swans" (Zysk, 2024) will be presented, which may facilitate the aforementioned identification of factors associated with international biopolitics.

According to the authors of this study, the subject matter under discussion is both significant and timely, as we can observe numerous rapid transformations in the conduct of international relations across geopolitical, social, technological, and economic domains.

2. LITERATURE REVIEW

2.1. Biopolitics: A Classical Approach

In Michel Foucault's classical, traditional, and original conceptualization, biopolitics functioned as an instrument through which power (identified with the state's coercive apparatus, tools, methods, and practices of exercising authority) could influence society and aspects of individual lives in their corporeal or biological dimensions. Interestingly, this concept was invoked by the Nazis (in the realm of "pure race" ideology), Karl Marx (in the mechanism assigning means of production in society to capital as a productive factor and in communist concepts of "production of man by man"), and Foucault himself, who in his analyses referred to the relationships between biopolitics and capitalism, liberalism, economic processes, and the evolution in the field of technology.

Thomas Lemke observes that the concept has been widely utilized not only by a narrow group of specialists but also by creators of national asylum policies, in disease prevention (e.g., AIDS), in modelling population growth and fertility rates, in supporting agricultural production, in regulating and planning medical research, in legal regulations concerning birth control and abortion, and even in so-called DNAR (do not attempt resuscitation) declarations signed by hospital patients.

Table 1. Summary of Some Research Results Focused on Biopolitics

Reference	Subject	Conclusions
Esposito, 2004	Bio and politics	The combination of the words "life" and "politics".
Fehér & Heller, 1995	Biological life and politics	The relationship between biological life and politics; "Hasn't politics always dealt with life?"
Heller, 1996	Politics and biological life	Politics can begin where biological life ends; politics transcending corporeality.
Mietzsch, 2002	The genesis of biopolitics	A temporal perspective on the origin of the concept of biopolitics; whether it dates back to ancient times, agrarian societies, or the beginnings of technological change.
Heins & Flitner, 1998; Buchstein & Beier, 2004	The genesis of biopolitics	Biological life as a pre-political foundation (naturalistic concept) or life processes as an extra-political subject of politics (politicist concept).
Foucault, 2010	Biopolitics	Modernity as the era of biopolitics, understood as biopower, population management, and the relationship between power and life.
Foucault, 2011	Biopolitics	Biopolitics as a driving force of Western civilization; the phenomenon of biopolitics and biopower as tools for organizing the lives of populations and individuals (instruments of control over individuals and entire societies, often linked to public health, security, and surveillance).
Lemke, 2010	Biopolitics	Presentation of the historical context and conceptual framework related to biopolitics.
Lemke, 2011	Biopolitics	A retrospective description of the concept of biopolitics as an innovative scientific method for analysing political processes.
Reid, 2005	Biopolitics and war, terrorism, and imperialism	The links between biopolitics and changes in globalization processes in the context of imperialism.
Virno & Holdren, 2002	Critique of biopolitics	"I don't negate that there can be serious content in the term, however, I see that the use of the term biopolitics is sometimes a consolatory use, like the cry of a child, when what serves us are, in all cases, instruments of work and not propaganda words."
Foucault, 2007	Biopolitics and liberalism	A comprehensive study of liberalism, neoliberalism, and their relationship to biopolitics.
Jaeger, 2010	UN reforms in the field of biopolitics	Utilization of Foucault's work and international relations research to "reprogram" aspects of sovereignty and global governance.

Source: own elaboration.

Moreover, biopolitics can be understood as the democratic and rational shaping of living conditions for individuals and society,

and as a way of organizing the life of a given population. However, this concept can also be applied in social exclusion planning policies, plans to eliminate the weak, sick, or disabled, in elements of eugenics (understood here as selective breeding of chosen, perfect specimens of the human species), as well as a tool and postulate of racist concepts or an argument for opponents of biotechnology (Lemke, 2011).

As can be observed, depending on the needs of particular power circles, this concept can be used or even appropriated to achieve various, often contradictory goals. Table 1 presents selected examples of attempts to define the concept of biopolitics in the subject literature.

To deepen the knowledge regarding further theoretical descriptions and definitions, it is appropriate for the authors of this study to refer to the detailed and multifaceted considerations of S. Wróbel (2011), M. Fałkowski (2011), M. Lazzarato (2011), J. Szczęch (2016), P. Kępski (2017), K. Gregorczuk (2020), J. Golinowski (2021), and J. Chustecki (2022 and 2024).

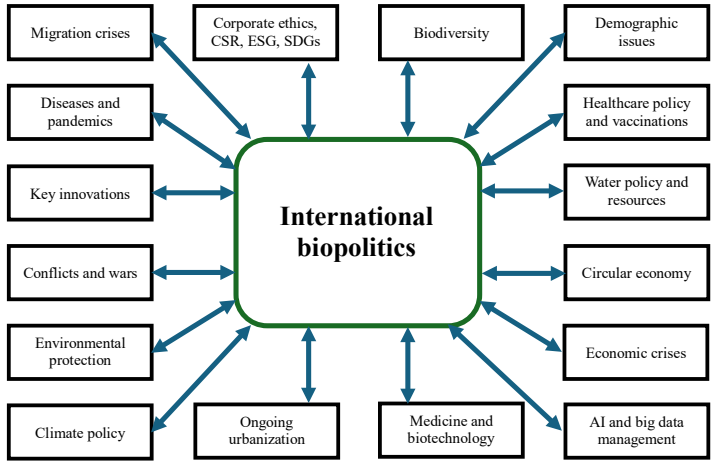
2.2. Biopolitics: An International Perspective

The aforementioned authors frame the concept of biopolitics in various structural configurations, ranging from totalitarian systems and communism to liberal-democratic models, and from individual to state biopolitics. In some approaches, individuals govern their own bodies, while in others, the state apparatus or government controls human bodies. However, this remains a traditional perspective, referring to the activities of a single, organized state entity that, through its organs and institutions (schools, courts, hospitals, security apparatus, military, and others), governs, secures, and organizes the lives of populations and individuals. It is worth emphasizing here that one of the most critical aspects of biopolitics is the issue of space in which the governing affect the governed (Foucault, 2010). Space should be understood here in a geographical sense, as an area of influence surrounded by state borders where rulers exert control over the ruled.

Since Foucault's considerations, however, a series of rapid changes have occurred in the global economy, beginning with the processes of globalization and the economic and geopolitical internationalization of human activity. We are also witnessing fruitful developments in

modern technology, medicine, and biotechnology, as well as a range of political and social changes in an international context. These changes have led to important, interesting, and profound transformations in the mutual relationships between biological life and politics, including international politics. As a result, a modern, contemporary biopolitics has emerged, which we can term international biopolitics.

Figure 1. Selected Areas Related to International Biopolitics



Source: own elaboration.

Individual nation-states, which possess appropriate tools and techniques for shaping the living conditions of populations and individuals, are losing their monopoly on this control (Gregorczuk 2020). International biopolitics focuses on more or less advanced cooperation between non-state bodies and institutions, such as transnational corporations, international research centres, various international organizations (WHO, FAO, UN, World Bank, European Union), and even grassroots social movements (non-governmental organizations) or civic initiatives.

These processes can be observed especially in relation to neoliberal economies, which prefer market deregulation, limiting the role of the state, or even privatizing many services directed at citizens. As a result, the broadly understood organization of population life (and simultaneously the responsibility for actions taken, as well as

omissions and errors) has shifted from the national, traditional level to a multinational, international level, where actions taken on regional or global forums have a key impact on the lives of entire social groups.

This approach allows for an attempt to identify and describe a number of factors influencing human well-being, quality of life, demographic aspects, health (including aspects of modern drugs, research, therapies, and vaccines, as well as epidemic management), environmental protection policy, ecology, migration policy, living conditions, and economic, political and social security, as well as other challenges in the geopolitical or international dimension, such as access to drinking water, food, resources, or energy.

Some scientists even claim that

> analysis of the contemporary international situation through the prism of Foucault's biopolitics actually shows us that our world system is characterized by parasitic imperialism of rich sovereign states over poor ones, implemented at the population level (Kelly, 2010).

It is also worth noting that contemporary international biopolitics combines population management strategies with issues of human rights, ethics, morality, and business responsibility, as well as global security.

It can therefore be concluded that biopolitics in an international, global perspective negates and undermines the existing, traditional concept of national sovereignty in the context of a given state. More and more action plans and decisions are being made at the supranational level. The sovereignty of individual states or nations in the aspect of international law (as understood, for example, in the United Nations Charter [UN, 2025]) has been called into question. Figure 1 presents selected areas related to international biopolitics.

It is worth mentioning here an important aspect - in light of the current international situation - of leadership and its role in geopolitical changes around the world. When we observe cross-border shocks in various areas of social and economic life and attempts to change the geopolitical order, some body or person then takes responsibility for actions taken or omissions using methods of strategic global or regional management (Zachara-Szymańska, 2023).

2.3. Exploring Global Governance through the Lens of Mutating Colourful Swans

At this point, it is worth attempting to classify various sudden and disruptive events that may influence the key elements of international biopolitics discussed earlier. Phenomena such as pandemics and different types of crises – primarily those that negatively (though not exclusively) impact economies – have been famously termed "Black Swans" by Nassim Nicholas Taleb (Taleb, 2020). These are unexpected, rare, and unpredictable events with no prior signs in history suggesting their likelihood. When they do occur, they exert profound effects on economies and societies. Interestingly, after they happen, some people retrospectively argue that these events were actually foreseeable. While Black Swans are often associated with negative outcomes – such as pandemics – they can also produce positive shocks, including breakthrough innovations, revolutionary scientific discoveries, or transformative investments that yield substantial benefits.

Expanding on Taleb's concept, the authors introduce an original framework of "mutating colourful swans", offering a fresh way to categorize impactful events relevant to international biopolitics (Zysk, 2024). In this approach:

- *Green Swans* represent climate change and its complex environmental and socio-economic consequences.
- *Red Swans* symbolize wars and armed conflicts, whether on a global or regional scale, with far-reaching implications for geopolitical stability.
- *Yellow Swans* reflect massive population movements and economic migrations, reshaping social dynamics and resource distribution.
- *Blue Swans* denote unexpected digital and technological disruptions, such as rapid advances in artificial intelligence (AI), emergent technologies, or shifts in cyber mentality – how individuals and organizations engage with digital environments from both demand and supply sides.

This "mutating colourful swans" concept provides a creative lens for identifying and understanding dynamic, often disruptive forces that shape the landscape of international biopolitics. By color-coding

and contextualizing these events, the model helps policymakers, researchers, and strategists better anticipate and respond to the evolving challenges and opportunities inherent in an interconnected, uncertain world.

3. METHODOLOGY

This article employs a mixed-method research design, integrating both qualitative and quantitative methodologies to analyse the key factors shaping international biopolitics. The qualitative component consists of a systematic literature review, which examines leading theoretical perspectives, historical developments, and conceptual frameworks related to biopolitics. Primary and secondary sources, including academic journals, policy reports, and institutional publications, were analysed to provide a comprehensive understanding of biopolitical governance. Additionally, document analysis was conducted, focusing on policy documents, international agreements, and regulations issued by global institutions such as the World Health Organization (WHO), the United Nations (UN), and the World Bank. A comparative approach was also utilized to identify cross-national variations in biopolitical strategies by analysing governance models, public health policies, and technological regulations implemented in different regions.

The quantitative component of the study is based on statistical modelling and index construction to measure the intensity and technological integration of biopolitical governance across different nations. A dataset was compiled from 16 countries, categorized into four income groups following the World Bank classification. To quantify biopolitical engagement, two synthetic indices were constructed: the Biopolitics Intensity Index (BII) and the Biopolitics Technological Index (BTI). These indices integrate multiple indicators, including health governance metrics, regulatory frameworks, and technological adoption indices. Multiple regression analysis was applied to examine relationships between these variables, with data normalization and weighting techniques implemented to enhance measurement reliability. The methodology also incorporates data validation procedures to minimize inconsistencies across sources and ensure robust analytical outcomes.

4. EMPIRICAL RESULTS AND DISCUSSION

As previously mentioned, the traditional concept of biopolitics finds its origins in the research of M. Foucault, who established the foundations for the present understanding of this phenomenon. According to this researcher, biopolitics is a unique method of exercising control over biological life (Foucault, 1990). Moreover, it represents a new form of power, that shapes the lives of populations and increases their productivity in favour of society. This concept is profoundly intertwined with the genealogy of power, the role of the state, and the mechanisms through which power operates (Lemke, 2011).

The original definition of biopolitics was proposed only a half century ago, so it was undoubtedly rooted in the international geopolitical situation of that time. In other words, in this time scope there has been visible evolution of contemporary biopolitics since then. Nowadays it can be described as decentralized, free market form of life management focused on commonly accepted and widespread values, especially in Western democracies. Among others, such values include self-realisation, ethics of authenticity (Taylor, 2018), or priority of quality of life. In contrast to the former biopolitics, in which population, race and nation were the primary categories (or cornerstones), the latter one is focused mostly on life quality of individuals. As a result, modern biopolitics strategies are based predominantly on risk management, vitality optimalization, and molecular-level interventions (Rose, 2007). Furthermore, biopolitics in many Western societies is organized through grassroots efforts, e.g. exerting pressure on government on specific medication or medical treatment refunds.

The evolution of biopolitics has led creation and development of bioeconomics, where biological processes became the source of profit, and biotechnology advancements result in so called biovalue creation (Waldby & Mitchell, 2006). Such transition from Foucault's macro-level biopolitics to the contemporary biopolitics based on advanced biomedical technologies creates many commercialization opportunities. In other words, biopolitics shouldn't be perceived as a tool of population control, but rather as a network of much more complex and dissipated processes, in which individual, responsible for its life and health, plays predominant, central role.

In contrast, international biopolitics is focused on global biological phenomena management, which includes public health, demographic policy, food security, and biodiversity, by supranational institutions and surveillance mechanisms (Cooper, 2008). Of course, such global biopolitics system is influenced by multitude of different factors, and many are not so obvious and measurable. For the purpose of this article, at least five key factors influencing international biopolitics can be distinguished:

1. *Economic factors*: They influence biopolitics by shaping the accessibility and distribution of healthcare and biotechnological resources. For example, high-income economies can be more effective in implementing, among other things, health monitoring technologies and epidemiological surveillance. Moreover, global economic disparities determine states' capacity to employ modern biopolitical measures. The intensity of global biopolitics is also influenced by the pharmaceutical market and investment in medical technologies (driven especially by big pharma), which is evident, for instance, in restrictions on the accessibility of medications and vaccines.
2. *Socio-demographic factors*: Population dynamics, societal aging, and migration have a significant impact on modern biopolitics. The growing number and proportion of older adults increase pressure on healthcare systems and their oversight, while migration flows necessitate a new approach to public health management. Among other important socio-economic factors that particularly influence domestic biopolitics are increasing cultural diversity, rising social expectations regarding health policy, and the pursuit of equitable healthcare access. Meanwhile, the intensifying pressure on states caused by escalating social inequalities requires the implementation of sophisticated population management methods.
3. *Political and regulatory factors*: Those determine both domestic and international biopolitics through laws, regulations, and political decisions, specifically regarding reproductive rights, medical data access restrictions, and privacy protection. Countries with stricter legislation often implement advanced population control measures and impose limitations on individual freedoms. In an international context, inevitable

differences in regulatory approaches may sometimes lead to conflicts, but can also foster cooperation in matters of public health protection. The most visible example of such cooperation and coordinated action was the global COVID-19 pandemic crisis from 2020 to 2022. Regarding political decisions, they shape the scope of the biotechnologies used and determine their degree of social acceptance.

4. *Technological factors*: Technological progress, particularly in digital technologies, artificial intelligence (AI), and biotechnology, are essentially reshaping contemporary approaches to population management. These tools enable rapid epidemiological surveillance, predictive disease analysis, remote citizen health monitoring (especially with the expansion of the Internet of Things (Gryczka, 2021)), and the implementation of precise health control measures. At the same time, they give rise to new ethical and legal doubts concerning privacy protection, individual autonomy, and potential abuses of power. Differences in the availability of these technologies also significantly influence the intensity of biopolitics between developed and developing nations.
5. *Environmental factors*: Given the intensifying global impact of climate change, it's evident that present biopolitics must address how states respond to ecological and climate issues that directly affect population health. Environmental degradation and ecological disasters – such as air pollution or zoonotic pandemics – increase the demands to implement more intensive biopolitical mechanisms. Growing awareness of environmental risks motivates societies to expect more effective action from governments, thereby promoting stricter public oversight of population health. It is worth underscoring that environmental factors frequently serve as a basis for global collaboration on biopolitics. At the very least, such a shift in perspectives should be expected and recognized in the years to come.

In addition to these primary factors shaping international biopolitics, supplementary determinants could play a significant role in forming a complex ecosystem influencing governance practices related to the biological aspects of population life. Such additional

factors include cultural and ideological conditions, historical experiences, institutional structures, security and surveillance measures, legal frameworks, and media and communication dynamics (e.g. Lemke, 2011; Rabinow & Rose, 2006). However, conducting a precise quantitative analysis of the impact of most of these determinants faces considerable challenges due to insufficient metrics and a lack of adequate statistical data.

For the purposes of further regression analysis, it was assumed that the impact of the aforementioned five factors on international biopolitics would be examined using available data from 16 countries – four from each income group as classified by the World Bank (low-income: Ethiopia, Madagascar, Malawi, Uganda; lower-middle-income: Bangladesh, Egypt, India, Nigeria; upper-middle-income: Brazil, China, Mexico, South Africa; high-income: Germany, Poland, Sweden, USA). This sampling structure allows for a comparison of biopolitical practices among countries with varying levels of economic development, facilitating the identification of both universal biopolitical mechanisms and specific patterns dependent on a country's wealth. Additionally, the construction of a synthetic indicator measuring biopolitical intensity (Biopolitics Intensity Index, BII) based on five component indicators, as well as a synthetic technology indicator (Biopolitics Technological Index, BTI) comprising four component indicators, have been proposed (see Table 2).

Table 2. Composition of Indicators Included in Regression Analysis

Indicator	Sub-indices	Weights
BII (dependent variable)	GHE (Domestic general government health expenditure (% of GDP), 2021	0.2
	UHC Service Coverage Index 2021	0.25
	Reproductive Policy Restrictiveness Index, estimation	0.3
	Global Health Security Index 2021	0.1
	Immunization coverage (DTP3) %, 2021	0.15
BTI (independent variable)	ICT Development Index 2024	0.15
	E-Government Development Index (EGDI) 2024	0.3
	Global Innovation Index (GII) 2024	0.15
	Government AI Readiness Index (GARI) 2024	0.4

Source: own elaboration.

The regression analysis indicates a positive and statistically significant relationship between BTI and BII (see Table 3 and Figure 2). The coefficient (0.4067) suggests that a one-unit increase in BTI is associated with an average increase of 0.4067 in BII. The model explains approximately 57.7% of the variance in BII, meaning that while BTI is an important factor, other variables also influence BII. The statistical significance ($p = 0.001$) confirms that this relationship is unlikely to be due to chance. This suggests that countries with higher technological advancement in biopolitics tend to exhibit greater biopolitical intensity, highlighting the role of technological factors in shaping biopolitical landscapes.

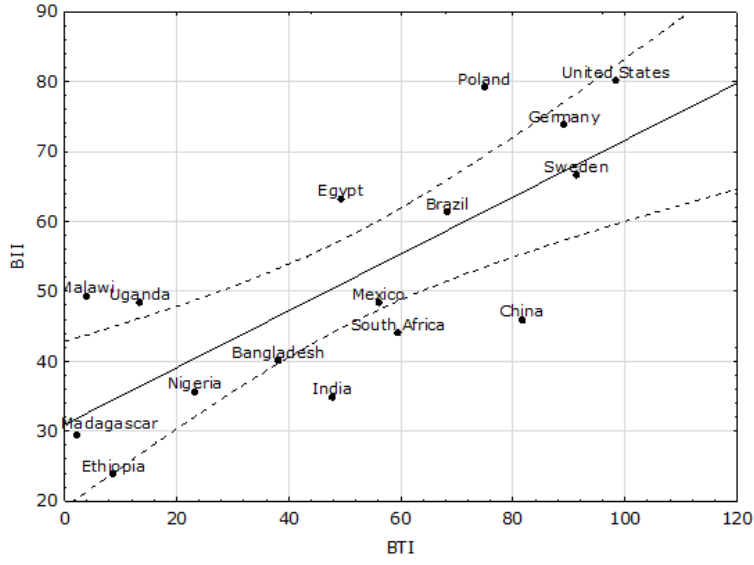
Table 3. Selected Results of Regression Modelling

Regression results	Comments
BII (Biopolitics Intensity Index)	Dependent Variable
BTI (Biopolitics Technological Index)	Independent Variable
BII = 30.95 + 0.4067 * BTI	Regression Equation
$R^2 = 0.577$	57.7% of the variation in BII is explained by BTI
p-value (BTI) = 0.001	Statistically significant

Source: own calculations using Statistica software.

To provide a more detailed analysis, let us assume that GII remains the independent variable, while all four technology-related subindices included in GTI are treated as separate dependent variables (see lower part of Table 2). The overall model is statistically significant ($p = 0.0127$), indicating that the combination of these technology-related indices explains a significant portion of the variation in BII. Specifically, the regression analysis suggests that technological factors collectively account for a substantial proportion (72.5%) of the variance in BII. However, no individual factor exhibits a strong, statistically significant effect. This may be attributable to multicollinearity or overlapping influences among the technology indices. Notably, the Government AI Readiness Index (GARI) has the highest positive coefficient (0.5140), implying that countries better prepared for AI tend to have higher BII scores; however, this effect is not statistically significant.

Figure 2. Scatter plot of BII against BTI



Source: own calculations using Statistica software.

In Table 4, five composite factors for the assessment of international biopolitics are presented. The multiple regression model employs BII as the dependent variable and includes five predictors: ECO, SOC, POL, TECH, and ENV. Based on calculations conducted using Statistica software, the model accounts for a substantial proportion of the variability in BII, with $R^2 = 0.699$, indicating that approximately 69.9% of the variance in BII can be explained by these predictors. The adjusted R^2 is 0.548, reflecting a reduction due to the number of predictors and the sample size. Overall, the model is statistically significant ($F(5, 10) = 4.641$, $p = 0.0189$), signifying that the predictors collectively have a significant relationship with BII. This suggests that countries with higher composite scores on these factors tend to exhibit higher BII values.

Table 4. Five composite factors for international biopolitics

Indicator	Subindices	Data source
Economic (ECO)	Poverty rate at $2.15 a day (2017 PPP) (% population) 2022	World Bank, WDI
	Unemployment, total (% of total labor force) 2023	World Bank, WDI
	Inflation, consumer prices (annual %) 2023	World Bank, WDI
	Globalization Index 2022	ETH Zürich, KOF Swiss Economic Institute
Socio--demographic (SOC)	Total Population Literacy Rate (%)	World Population Review
	Mortality rate, infant (per 1,000 live births)	World Bank, WDI
	Urban population (% of total population) 2023	World Bank, WDI
	Human Development Index 2022	United Nations Development Programme
Political (POL)	Corruption Perception Index (CPI) 2024	Transparency International
	Political Stability and Absence of Violence/Terrorism	World Bank, WDI
	Regulatory quality index 2023	www.theglobaleconomy.com
Technological (TECH)	ICT Development Index 2024	ITU
	E-Government Development Index (EGDI) 2024	publicadministration.un.org
	Global Innovation Index (GII) 2024	WIPO
	Government AI Readiness Index (GARI) 2024	oxfordinsights.com
Environmental (ENV)	Per capita CO_2 emissions, tonnes, 2023	ourworldindata.org
	Energy use (kilowatt-hrs per person), 2023	ourworldindata.org
	Environmental Performance Index 2024	epi.yale.edu

Source: own preparation.

Although conducted multiple regression analysis indicates that BII is strongly associated with the set of five synthetic indices as a whole (good model fit and significant overall relationship), it cannot confirm any single predictor as a standalone significant driver of BII, because these predictors are highly correlated with each other. The residuals satisfy regression assumptions (linearity, normality, homoscedasticity, independence), lending credibility to the model itself, but the presence of multicollinearity and an influential outlier

suggests exercising caution. The key conclusion is that improving the broad mix of economic, social, political, technological, and environmental factors is associated with higher BII, even if we cannot statistically separate which of those factors matters the most given this dataset. However, due to some statistical limitations, like e.g. multicollinearity, one should be cautious in attributing changes in BII to any one factor in isolation.

While presented regression analyses yield quite valuable insights, at least three methodological constraints warrant consideration. First, the restricted country sample size constrains statistical power and limits the model's capacity to reflect global heterogeneity, suggesting expanded geographical representation could strengthen external validity. Second, the reliance on aggregated indices, though analytically expedient, may obscure sector-specific dynamics – for instance, conflating biotechnological adoption in healthcare with agricultural innovations. Disaggregating metrics by domain could illuminate nuanced relationships. Third, operationalizing biopolitics through a single composite index (BII) presents inherent conceptual tensions, as its context-dependent nature – intertwining ethical governance, technopolitical infrastructures, and cultural values – resists reduction to linear quantification. These limitations, common in cross-national policy research, highlight opportunities for methodological refinement: diversifying datasets to include underrepresented regions, integrating granular indicators tailored to specific sectors, and complementing quantitative frameworks with qualitative case studies to capture biopolitical complexity. Such iterative enhancements would not negate the current findings but deepen their empirical and theoretical relevance.

5. CONCLUSION

This article proposes a conceptual framework for analysing international biopolitics by identifying current determinants and forecasting future processes shaping this field. Central to the analysis is the original Mutating Colourful Swans model, which categorizes biopolitically significant phenomena to address the complex interplay of forces redefining transnational governance. The study positions

international biopolitics as a dynamic phenomenon shaped by globalization, technological advancement, and evolving paradigms of collective human existence across nations, social groups, and individuals. These issues are pivotal to redefining transnational cooperation in an interconnected world, spanning social, political, scientific, technological, and economic dimensions.

A multifactorial regression analysis incorporating five composite indices demonstrated that these domains collectively explain 70% of the variability in the Biopolitics Intensity Index (BII). However, the lack of individual statistical significance among predictors due to high multicollinearity underscores systemic interdependencies within international systems. This finding reveals that biopolitical dynamics emerge from synergistic interactions among co-evolving domains rather than isolated factors. Methodological limitations, such as a restricted country sample and challenges in operationalizing biopolitics into a single index, emphasize the necessity of integrating scenario-based foresight into biopolitical analysis.

On the other hand, proposed Mutating Colourful Swans framework classifies biopolitical risks and transformative processes. Green Swans represent systemic climate crises, such as resource scarcity or ecological collapse, destabilizing environmental, economic, and social structures. Yellow Swans denote global migration pressures linked to climate displacement or demographic disparities. Red Swans encompass geopolitical manipulations, cyber conflicts, and ideological shifts disrupting political-regulatory stability. Blue Swans involve unforeseen technological breakthroughs in AI, biotechnology, or quantum computing; occasionally, gradual risks such as AI-driven labour market disruptions are also described as Grey Swans (Aon, 2021; Brooks, 2024). The integration of quantitative regression analysis with qualitative scenario frameworks enhances the capacity to interpret structured trends and disruptive events in international biopolitics. This dual approach is critical for developing adaptive governance systems capable of navigating predictable developments and systemic shocks. Future research must prioritize interdisciplinary collaboration, expanding empirical datasets, refining biopolitical metrics, and fostering real-time biosurveillance networks. The study underscores the imperative for resilient governance models that harmonize empirical rigor with strategic flexibility, ensuring

preparedness for incremental transformations and existential disruptions alike.

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