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GOVERNMENTALITY OF TECHNO-BIOPOLITICS AND THE BIO-ECONOMY OF ASSISTED REPRODUCTIVE TECHNOLOGY

Assisted reproductive technology (ART) plays a crucial role beyond the treatment of infertility, serving as a tool for population growth with significant social, political, and economic implications. This study examines how ART contributes to state biopolitical and economic objectives, highlighting the shift from traditional biopolitical strategies to techno-biopolitics, where reproductive interventions are increasingly technologized. As populations become targets of power, the primary risks to biopolitical security are no longer geopolitical conflicts, but natural threats that affect public health. Neoliberal governance constructs these threats discursively, shifting responsibility from the state to the individual. This strategy of responsibilization transforms infertility from a social problem into a personal one, directing individuals towards commercialized fertility solutions. Furthermore, the fertility market operates within a politically shaped moral economy in which biovalue is socially and culturally constructed. The supply-demand dynamics of ART are influenced by socio-political factors, as the state benefits from population growth in terms of human capital, i.e. consumers, taxpayers, and labour contributors. This study highlights the intersection of ART, biopolitics, and the bioeconomy, showing how reproductive technologies function as mechanisms of governance while shaping economic and demographic landscapes.

Keywords: assisted reproductive technology, biopolitics, bio-economy, governmentality, stigmatization, medicalization

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Introduction

Assisted reproductive technologies (ART) treat infertility, offering couples who are unable to conceive naturally the chance to have children. Beyond medical intervention, ART has significant social, political, and economic implications. Its development is prompting discussions on ethical norms, legal regulation, and demographic consequences, underlining its relevance to public policy.

ART has been studied across a range of disciplines, including religion, feminism, bioethics, economics, and demography. Economic impacts have been studied since the early development of ART (Ata, Seli 2010), and recent research has explored cultural influences on the reproductive technology market and power dynamics in biopolitics (Salter 2022). Religious perspectives on ART are analyzed by Inhorn (2011) and Matthews (2021), while feminist studies highlight concerns about the objectification and commodification of the female body (Nisha 2021). In Russia, bioethics research indicates a largely positive public perception of ART (Isupova, Rusanova 2021). In addition, particular attention is paid to the contribution of ART to the dynamics of the demographic crisis (Chernyavskaya 2018).

This study offers an innovative perspective by framing ART as a techno-biopolitical phenomenon. The study examines the interplay between ART and social, political and economic factors, highlighting how these elements influence individual empowerment. ART is analyzed beyond its medical function to include its social, political, and economic implications. It shows how these factors influence reproductive behavior and encourage individuals to make autonomous decisions in line with socio-economic and political conditions. The study highlights the perception of the population as human capital, subject to state regulation through policies that promote individual responsibility for managing infertility. It also examines the impact of state and technological mechanisms on reproductive choices and the economic significance of ART in contemporary society.

This study uses Michel Foucault's (2008) concept of governmentality to frame ART as an instrument of biopolitical population management. Using a secondary data analysis approach, the author examines existing case studies, recent scholarly articles, textbooks, and statistical data on ART. By contextualizing these sources within a theoretical framework of biopolitical governmentality, the study analyses both quantitative and qualitative data sets to explore ART as a social, cultural, and political phenomenon. A key focus is the role of state policy in regulating access to ART and its impact on demographic processes.

To achieve their biopolitical goals, countries need to address the rising demand for reproductive technologies in the face of changing birth rates and increasing infertility. At the same time, social policies should inform the public about the effects of modern lifestyles and delayed parenthood while tackling

the stigma associated with infertility. Ensuring equitable access to ART is increasingly central to broader biopolitical and bioeconomic strategies aimed at balancing individual reproductive needs with societal demographic goals.

Techno-Biopolitics: Governing Life through Assisted Reproductive Technologies

Michel Foucault's concept of biopolitics describes how modern political power regulates populations by managing bodily issues such as birth rates, mortality, health, and life expectancy (Foucault 1984: 139). These mechanisms form a 'biopolitics of the population' that seeks to improve the quality of life and influence demographic metrics. Biopolitics aims to optimize the life of the population both biologically and socio-economically. A key aspect is state intervention in reproduction, emphasizing its role as a fundamental component of biological life (Dillon 2017: 101). Thus, biopolitical regulation extends beyond traditional healthcare to include fertility management, reproductive technologies, and demographic strategies.

Biopolitics functions as a system of control and a mechanism for active intervention in demographic processes. In contemporary societies, this is implemented through techno-biopolitics, i.e. the governance of reproductive capacities through medical technologies and regulatory frameworks. This enables the state to develop long-term strategies for demographic growth while simultaneously controlling access to assisted reproductive technologies and influencing the reproductive behavior of the population.

State biopolitics aims to regulate the size and quality of the population. . Under neoliberal governance, this regulation is achieved not through direct control but by creating conditions that encourage individuals to align their choices with state strategies (Foucault 2008: 13). Rather than imposing strict policies, the state encourages autonomy by promoting self-regulation in reproductive behavior, health maintenance, and economic adaptation. This approach optimizes biological characteristics while increasing financial efficiency. Freedom of choice becomes a key regulatory tool: state objectives are achieved through voluntary choice rather than coercion (Hindess 1996: 125). For example, instead of prohibiting late pregnancies, the state supports early parenthood through social programs, access to ART, and reproductive health education, thereby influencing individuals to make choices that are consistent with policy objectives.

Neoliberal governance shifts responsibility for well-being from the state to the individual. Instead of direct control, conditions are created in which individuals self-regulate under economic and social pressure. Financial obligations and social expectations encourage personal responsibility, leading to self-discipline and compliance with social norms. As a result, social problems become

personal burdens and failure to meet expectations is seen as an individual fault (Lazzarato 2012: 122–128). This mechanism extends to life strategies, intertwining population management with the individuals' duty to monitor their behavior and conform to societal ideals of the 'good life' (Lindner 2020).

Modern biotechnologies have shifted responsibility for health from public institutions to individuals. Medical care is now seen as a personal obligation, with individuals encouraged to pay for services and resources to maintain their health and reproductive function. Each person is seen as a self-governing individual who must invest in their body and health much like any other life asset. Public discourse and media narratives reinforce the idea that caring for one's body is not merely a personal choice but a necessary investment in quality of life and social success.

Beyond the influence of public discourse, technological advances are reshaping health and life management. Human existence is increasingly technologized, forming a biopolitical strategy in which technology plays a central role. This 'techno-biopolitics,' reflects new connections between politics, life, and technology (Lipp, Maasen 2022). Public discourse constructs problems or threats, while technology provides solutions to regulate biological issues. As a result, technology becomes an integral part of self-governance, shaping access to information, the environment, interactions, and body management. This applies to both digital technologies and biomedical technologies, which influence treatments and the very perception of life in a technologized society.

Techno-biopolitics introduces a new mode of governing life in which technology becomes integral to the regulation of the human body. In this context, the body is perceived as a form of 'molecular software' that requires technological intervention for its management (Ibid). Modern biotechnologies fundamentally transform traditional biopolitical strategies, establishing a techno-biopolitical regime. Here, the regulation of health, reproduction, and basic biological processes is carried out through technological tools that not only affect the body but also establish new norms for its functioning.

In the digital age, perceptions of the body and life are undergoing a radical shift that is reshaping biopolitics. Governance is now 'mobile and fluid,' focusing not just on territory or population but on dynamic molecular processes within the body. Life is seen as a continuous process of adaptation, resisting rigid control and requiring flexible management (Dillon 2017: 171–186). Biopolitics has moved beyond national boundaries and stable population categories, aligning itself with evolutionary processes and human biological development. As the body is no longer seen as a fixed object of power, new regulatory mechanisms are required that differ from traditional geopolitical strategies. Rather than governing territories, biopolitics now focuses on controlling biological processes, genetics, and the interaction of technology with the body, reshaping the management of life. In the modern world, people are seen as dynamic systems shaped by interactions with their environment. Lacking a fixed identity, their material nature renders security concerns fluid and open

to reinterpretation. Biopolitical security establishes norms that define which bodies and social relations are considered 'normal' and which are considered deviant or threatening. Governance aims to enhance positive factors while mitigating risks from disease, environmental change, and other natural threats. As population size becomes a political priority, infertility takes on biopolitical significance. Security governance now extends beyond disease prevention to the development of society's reproductive capabilities (Dillon 2017: 63).

Technological intervention in childbirth has become a tool of medical and biological control, transforming reproductive processes into a domain of medical regulation. As states prioritize demographic growth and human capital management, reproduction moves from a medical concern to a political issue. As a result, biological processes become subject to political control, while political decisions regulate life itself. Infertility has moved to the forefront of social and political debate, from a purely medical diagnosis to a social and cultural issue requiring state intervention. This shift results in dominant political forces regulating and controlling reproductive choices, justifying their involvement in terms of the perceived 'natural' biological needs of society. Life is thus governed by two parallel processes: science and medicine regulate biological functions, while political governance determines whose lives are prioritized for support and enhancement.

The evaluation of which lives are valued and which are marginalized takes place at the intersection of biopolitics and economics. This biopolitical economy seeks to maximize the utility of life while minimizing its 'useless' aspects. In this context, state policies regulate not only the population but also the very definition of life, blurring the boundaries between the 'proper' and 'improper' existence. This biopolitical regulatory mechanism underpins the development of capitalism, as the economic system evaluates life through the lens of domination, exploitation and material utility (Bird, Lynch 2019). Surrogacy is an example of this bioeconomy, integrating the human body into economic systems. Another key aspect is the economic benefits of ART, which this study explores. Our research shows how politics, economics, and biotechnology are converging to shape new frameworks for the governance of human life.

Challenges of Assisted Reproductive Technologies

ART is a branch of biotechnology that applies scientific advances to improve the quality of human life. By integrating natural biological processes with scientific methods, ART blurs the boundaries between nature and culture and redefines the concept of the 'natural' human body.

Technological intervention in human life has provoked critical debate. Scholars influenced by the Frankfurt School see biotechnology as a means of controlling and modifying nature for the benefit of society. They argue that technology, developed under capitalism, becomes an instrument of power and market domination. This technocratic approach, which favors technical solutions over political regulation, does not lead to human liberation, but reinforces

dependence on technology and material goods, and centralizes them in the governance of life (Delanty, Harris 2021).

Biotechnological interventions in ART face significant ethical and social contradictions. Debates continue between proponents and opponents about the acceptable limits of intervention in nature. Some activists and scholars view biotechnologies as violating fundamental boundaries between the natural and the artificial, the sacred and the secular. Jeremy Rifkin, for example, argues that biotechnology disrupts traditional conceptions of life, while George Annas advocates for a global ban on reproductive cloning (Davies 2006).

Advocates of technological dominance over nature see it as inevitable and emphasize individual freedom of choice in the use of ART, provided that no direct harm is done to others (Sutton 2009: 141). States actively regulate biotechnology and integrate it into cultural, religious, and medical frameworks. As a result, biotechnologies become part of the power system, where political, social, and cultural institutions define their boundaries, control their dissemination, and establish norms for acceptable intervention.

Biotechnology is undoubtedly having an unprecedented impact on population growth, as its applications overcome natural limits in terms of health and resources. Modern technologies increase fertility rates, reduce mortality, and increase birth rates. However, this achievement is perceived differently according to ideological perspectives: for some it is progress, for others it is a threat. Ecologists and scientists warn that ART-induced increases in birth rates are driving up carbon emissions and straining ecosystems (Richie 2015). They argue that technological progress, demographic expansion, and a belief in the sacredness of life contribute to environmental risks. Malthusian theorists see overpopulation as a crisis leading to resource depletion and claim that when the population growth exceeds the availability of food and resources, a demographic decline is inevitable (Merchan 2022).

Population growth, coupled with rising consumption, threatens the environment and quality of life. Yet despite an escalating ecological crisis, overpopulation is often ignored or dismissed by society and the scientific community. Government policies that prioritize demographic expansion overshadow these concerns. Many governments adopt 'pro-child policies' to increase population size in order to gain economic and political advantages over less populous nations, viewing growth as a resource rather than a threat (Kopnina, Washington 2016). From the government's perspective, population serves as an economic asset as it includes consumers, taxpayers, and laborers who are critical to socio-economic stability. Recognizing its economic and political importance, states are actively addressing declining birth rates and implementing strategies to stimulate demographic growth.

Cultural and technological advances contribute to declining birth rates. Expanded rights and access to education lead to delayed motherhood, which indirectly reduces birth rates. This process is sometimes seen as an indirect

form of contraception (Atake, Gnakou 2019). Studies of Russian women since the 1990s confirm a direct link between aspirations for social advancement and delayed motherhood. As a result, demand for ART has risen, as these technologies become essential for women planning to have children later in life (Spridonov, Polyakova 2024).

Technological advances have led to environmental changes that negatively affect reproductive health. Exposure to environmental toxins, such as endocrine disrupting chemicals found in plastics and pollutants, has been linked to infertility (Jain, Singh 2023). Given the pervasiveness of technology in modern life, addressing these challenges requires a scientific approach. Contemporary studies of culture and technology aim to adapt society to these evolving conditions, exploring ways to mitigate the negative effects of technological progress on health and well-being (Delanty, Harris 2021).

Techno-Biopolitics and Problematization of Infertility

Infertility is increasingly recognized as a biopolitical category, subject to scientific, medical, and cultural regulation. Within biopolitics, infertility is constructed as a scientific problem requiring solutions through biotechnology and biomedicine, and as a cultural phenomenon, linked to notions of normality. Medically, infertility is problematized as a threat to the healthy functioning of the body that requires intervention. Culturally, it is stigmatized as a deviation from the norm that challenges traditional notions of full subjectivity. This medicalization and stigmatization transforms infertility into a socially and biologically significant threat, disrupting the boundaries of what is considered a 'normal' human body, both physiologically and culturally.

Erving Goffman defines stigma as a deeply discrediting attribute that reduces an individual 'from a whole and usual person to a tainted, discounted one' (Goffman 2009: 2–3). In many societies, having children is considered the norm and an important part of the social structure. Couples without children may be seen as violating these cultural expectations, leading to their stigmatization. Thus, childlessness, especially when unintended, becomes a cause of social isolation and prejudice.

Studies conducted in countries such as Iran (Taebi et al. 2021), China (Xie et al. 2023), Japan (Yokota et al. 2022), and Turkey (Höbek Akarsu., Kızılkaya Beji 2021) show that infertility often leads to family and social stigma. This stigmatization burdens individuals with feelings of worthlessness and social isolation, which negatively affects their physical and mental health. In societies where procreation is a cultural tradition that is essential for the maintenance of the social system, infertile couples are perceived as deviating from these expectations, which intensifies their sense of stigma.

Stigmatization and medicalization are interrelated processes that shape society's perception of different phenomena. Stigmatization occurs when certain conditions or behaviors are seen as deviations from societal norms, leading to social

disapproval. Medicalization involves the redefinition of social or personal issues as medical problems requiring treatment (Greil et al. 2011). For instance, infertility has moved from being seen as a private concern to a medical condition, illustrating how non-medical issues can become medicalized (Williams, Gabe 2015).

The inability to reproduce biologically is viewed as a deviation from cultural norms, a disruption of the tradition of procreation. This perception underlies the medicalization of involuntary childlessness, referred to in medical discourse as 'infertility.' As a result, infertility has been 'redefined as a disease' (Becker, Nachtigall 1992). In 2002, the *British Medical Journal* conducted a survey to identify conditions that were considered 'non-diseases.' Infertility appeared on the list of disputed conditions as a 'variant of normal.'

The framing of infertility as a threat brought medical experts to the fore. In the 1950s, the development of fertility drugs marked the beginning of the medicalization of infertility in the US. Research into medicalization has identified different levels of medical involvement with people facing infertility. Some use highly medicalized approaches, while others prefer non-medical methods. This variability highlights the dynamic nature of medicalization, which is influenced by cultural and political factors, rather than being a fixed state (Greil et al. 2020). Understanding a social or political problem as a medical one requires medical solutions. Infertility has become a condition to be treated. Once it was perceived as 'a medical issue requiring treatment,' people began to 'refer to it in such a manner' (Bell 2016).

The portrayal of infertility as a threat has made so much a part of everyday life that it is rarely discussed in terms of security. However, when seen as a threat to national demographics, infertility becomes a security issue. In order to increase the birth rates, the state adopts an approach that makes citizens responsible for infertility treatment. Due to the lack of universal insurance coverage for such treatments, individuals often have to deal with this issue on their own (Insogna et al. 2018). In this way, citizens demonstrate that the state's demographic goals are being met through governance methods that encourage them to pay for infertility treatment services themselves.

The medicalization of fertility that has permeated consumer culture encourages individuals to purchase idealized fertility technologies in order to achieve desired reproductive capabilities. Stereotypes about infertility create an environment that justifies technological interventions in the body. By making autonomous choices, people invest in biotechnological services in order to conform with cultural and biological norms, which, in turn, supports the demographic objectives of the state. This view of life, in line with a biotechnological approach and advances in population management, benefits the bioeconomy.

Bioeconomy and ART: Economic and Social Aspects

The bioeconomy encompasses economic activities that use biological resources, processes, and principles to produce goods and services across various

sectors (Gallo 2022: 2). It involves the knowledge-based production and use of renewable biological resources to provide sustainable solutions across all economic sectors (Dietz et al. 2024: 14). The reproductive bioeconomy examines how reproductive materials and services are integrated into the economic system (Vertommen 2022). ART, such as in vitro fertilization, uses biological resources and represents an interaction between nature and society (de Schutter et al. 2019). Although ART is based on biotechnologies, it is also linked to industrial, social, and economic aspects. Viewing the stages of embryonic development as separate products (sperm, egg, embryo), and the technologies that facilitate their selection and creation, has led to new markets offering these products and choices (Cohen 2015).

As an industrialized life science, ART has a direct and indirect impact on the economy. Indirectly, this impact can be seen in areas such as reproductive tourism. The criminalization of egg trafficking in certain conservative societies, such as Australia and France, leads ART clients to seek infertility treatment in countries with more lenient regulations (Waldby 2019b). Furthermore, demographic crises and the need to establish a sustainable national workforce increase the political and economic demand for ART (Ghinea 2022).

ART has a direct economic impact through the commercialization of biological materials. Items such as sperm, oocytes, embryos, and blood are transformed into commodities and sold in markets that turn patients into customers. The processes of producing, managing, and storing these materials for research, treatment, or preservation have integrated them into the economic cycle. It is estimated that the global fertility industry will grow from $25 billion in 2019 to $41 billion by 2026 (Waldby 2019a).

ART operates within a moral economy shaped by political factors. Demand for ART services is influenced by socio-cultural narratives that guide individual behaviors and clinical decisions. On the supply side, the introduction of new ART services requires institutional validation, which can be achieved either by adapting existing values or by establishing new ones (Salter 2021). Acceptance of ART services depends on how cultural and social authorities, such as religious institutions or bioethical bodies, regulate their distribution to consumers.

The value of the ART market is regulated by institutions, while biological value is shaped by sociocultural flows that are subject to institutional constraints or legitimizations. This dynamic between cultural and biological values governs supply and demand, as the management of the commodity economy of ART's through the moral economy influences the growth or decline of the market. The global ART market has been expanding since 2018 and is projected to reach $45.06 billion by 2026 (Pawar 2024). In India, the significant growth of the privatized ART industry is influenced by cultural factors where gender roles are stereotypically defined, childlessness is considered 'abnormal,' and infertility is stigmatized (Nadimpally, Venkatachalam 2016).

The commercialization of biotechnology, including practices such as surrogacy and organ transplantation has a dual impact: it contributes to economic growth, but it can also exacerbate social inequalities by primarily benefiting certain social classes. Phenomena such as reproductive tourism, bio capital, and the global market for biotechnological devices illustrate how biotechnology serves as an economic driver in our consumer-oriented society. The technological and discursive governance of populations, a central goal of techno-biopolitics, creates self-regulating individuals who, as consumers, pay for technologies to manage their physical conditions that are deemed abnormal.

ART offers significant bioeconomic benefits by addressing infertility and contributing to demographic stability. Individuals born through ART become part of future generations, serving as human capital, future members of the workforce, and taxpayers (Connolly et al. 2021). Studies show that a child conceived through in vitro fertilization (IVF) is a net positive revenue for the state, taking into account future earnings, health care costs and life expectancy (Connolly et al. 2008). Another study confirms the long-term economic benefits of ART, suggesting that ART can be viewed as a beneficial investment from a societal perspective due to its positive impact on net revenue (Chambers et al. 2009).

While ART is a major contributor to the bioeconomy, concerns remain about equitable global access and potential class disparities. Barriers such as the high cost of treatment, limited clinic availability, and lack of insurance coverage can limit access to ART services, particularly for those from lower socioeconomic backgrounds. Typically, egg donors are young women from precarious economic backgrounds, while recipients are often white, middle-class women (Waldby 2019a: 6). There are also inequalities in egg donation. Research shows that African American donors are underrepresented compared to their proportion in the U.S. population, highlighting racial disparities in donor availability (Tsai et al. 2022). To address these disparities, it is essential to monitor and formulate ART practices in line with sustainable equitable access goals.

Conclusion

This study examines how ART functions as an instrument of techno-biopolitics and bio-economics. Using Michel Foucault's concept of governmentality, it explores how the framing of infertility as a stigmatized medical condition aligns individual self-regulation with the biopolitical and bio-economic objectives of the state. By framing infertility as a threat to a normal lifestyle and offering technological solutions, individuals are encouraged to use ART. The research examines the convergence of technology, politics, and biology, and introduces the concept of 'techno-biopolitics' in the context of infertility governance. It shows how political strategies use technology to intervene in biological processes in order to achieve biopolitical goals. Furthermore, the study

develops the notion that the articulation of a biological threat and the internalization of its technological solution serves as a means of directing the behavior of self-governing individuals in line with state objectives.

The political and economic importance of populations often overshadows environmental concerns. Population is an integral part of tax systems and consumption, making it a crucial component of economic structures. This perspective can lead to the prioritization of economic growth over environmental sustainability. For instance, policies that encourage population growth to increase economic output may inadvertently exacerbate environmental degradation. Balancing these competing priorities remains a major challenge for policymakers.

The state's valuation of the population as human capital leads to selective interventions in the biological lives of certain groups while neglecting others, with the aim of increasing both the quality and quantity of 'acceptable' subjects. This process exemplifies the technologization of biopolitics, with reproductive technologies serving as tools for life management. The convergence of biopolitics and economics manifests itself in two key ways. First, as a biopolitical economy of life, it delineates the boundaries of 'right' and 'wrong' life, establishing norms of biological value. Second, as an economic mechanism, it generates financial benefits for the state through the regulation of the reproductive market.

The ART market is shaped by economic factors and cultural, moral, and political elements, which are influenced by local moral economies established through state governance mechanisms. A state's ability to globalize its moral economy of ART could serve as a tool of political and economic power, which warrants further research. By investing in infertility treatment and improving the health of its citizens, the state manages public health and population reproduction, leading to savings in healthcare costs, population growth, and additional revenue from the sale of biological goods and services.

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