Changing the Female Biocapital Market via Reproductive Technologies

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Changing the Female Biocapital Market via Reproductive Technologies: A Potential Future with Genome Editing, Ectogenesis, and In Vitro Gametogenesis

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Abstract

This paper explores how social changes and scientific developments could change the female biocapital market. It considers what the potential future use of in vitro gametogenesis, genome editing, and ectogenesis as reproductive technologies, could mean for the female biocapital market. This paper details social shifts in cultural norms and values, and how these changes could impact policy changes in the United Kingdom. The paper also discusses how policies surrounding reproductive technologies influence applications and the use of them in a globalised, transnational market, and how their development may impact fertility tourism, social inequalities, and women's lives.

Keywords: biocapital, ectogenesis, genome editing, in vitro gametogenesis, reproduction

1. Introduction

1.1 Key Definitions

Susanne Lettow (2018, 13), a German Philosopher, explains that biocapitalism can be defined as the valorisation of materials derived from human bodies and non-human living beings, i.e. biocapital. Examples of biocapital include organs – such as ovaries and uteri, genes, and cells – such as blood, skin, and gametes. Lettow argues that the valorisation of biocapital enables them to be subjected to, used, and exploited for capitalist accumulation strategies and modes of labour, as other goods and services would be in markets.

This paper explores how biocapital associated with or derived from females, specifically those relating to human reproduction and child rearing, could change the biocapital market.[1] In this paper, «female» refers to the sex that can anatomically gestate offspring or produce eggs, whether this be from cis advantage or trans enabling interventions. This paper criticises the division between production and reproduction using technologies by putting them at the centre of social theory. This is done by building on the framework of a French social anthropologist, Noémie Merleau-Ponty's (2021), concept of «sociology as a technology» as a lens for projective sociology. The concept encapsulates an interdisciplinary approach to addressing the ways in which societies influence applications of scientific knowledge and capabilities for practical or socially desirable purposes. The division is considered, with implicit Marxist feminist ideologies and explicit

[1] This paper reserves foci to females as female biocapital remains the most exploited, and could be where the impact of reproductive technologies makes substantive change.

recognition to risk, via three theoretical reproductive technologies (RTs) - genome editing (GE), ectogenesis, and in vitro gametogenesis (IVG).

RTs are interventions designed to control, assist, or prevent conception. These technologies have afforded females greater autonomy over their reproductive capacities and expanded the ways in which their biocapital can be valorised. The introduction of in vitro fertilisation (IVF) paved the foundations for the development of a breadth of other RTs, collectively referred to as assisted reproductive technologies (ARTs) (Franklin, 2022).[2] Melinda Cooper and Catherine Waldby (2014), both Australian sociologists, argued that the introduction of ARTs extended the labour theory of value, such as that traditionally associated with gestation and child rearing, to «clinical labour». This is because ARTs enabled new ways, established in clinical settings, for female biocapital to be valorised. Some forms of biocapitalism in the realm of ARTs can therefore be considered as «clinical labour». Thus, both of these terms will be used in this paper.

Genome editing refers to scientific techniques that can be used to make changes to the DNA in individual cells by adding new, replacing, or deleting existing parts of DNA. Theoretically, this technology, among other applications, could be used to prevent an embryo having a genetic disease which is known to affect its biological parents (Ormond et al., 2019). Techniques to enable the efficacy of genome editing for human reproduction, i.e. germline genome editing (GGE) are still being developed. Although scientific progress continues to be made, the techniques are not yet considered effective enough for such application (Ledford, 2023).

Ectogenesis is the partial or complete gestation of a developing embryo or foetus outside of the human body. This process is more tangibly expressed via its more common reference, «artificial wombs». To date, this technology has only been used to partially gestate animals, namely kids (baby goats) and lambs (Romanis, 2018; Kendal and Bhatia, 2019). Currently, applications of such technology are dependent on foetal anatomy and therefore the possibility of full ectogenesis, i.e. growing an embryo created via IVF complete outside of the human body, is totally theoretical (Romanis, 2020a). In addition to premature births, proposed applications for partial ectogenesis centre on relieving females from clinical labour and high-risk pregnancies which could be damaging to maternal health, and perhaps long-term reproductive capacities.

IVG is an experimental technique that reprogrammes adult cells, such as skin or blood cells, to become sperm or egg cells (Notini, Gyngell and Savulescu, 2020). The technique was successfully used in March 2023 to produce mice from two male mice (Devlin, 2023). Similar to the other technologies, IVG also holds promise to changing the female biocapital market (FBM) (Suter, 2016). This technology would mean that females affected by various fertility issues could be afforded a route to bypass the invasive and risky egg retrieval practices currently required for IVF (Fauser and Devroey, 2003), and could be a route to avoid some forms of clinical labour. This could enhance the reproductive capacities of some females. However, none of these technologies are permitted in any country for applications relating to human reproduction; critical consideration must be extended to why this is.

1.2 Legal Positions

[2] IVF is a process through which an egg cell is fertilized by a sperm cell outside of the human body.

The United Kingdom (UK) was the first country to create legislation to specifically address RTs focused on or stemming from IVF. This legislation is called the Human Fertilisation and Embryology (HFE) Act 1990. The Act was amended in 2008 to primarily address matters relating to «ad-mix» embryos, i.e. embryos with human and non-human material (Birk, 2009). The amendments intended to strengthen the UK's stance on clinical applications and research which involve gametes and embryos outside of the human body. This Act has been a cornerstone for legislation across the globe relating to such matters. The legal positions of the three named technologies will therefore be discussed in relation to this Act before mentioning specific stances in other countries.

1.2.1 Germline Genome Editing

In 2008, the concept of GGE was not advanced. This meant that amendments in the HFE Act relating to GGE were not particularly developed and make some of its intentions fallible due to the wording used in the Act (Kaur, 2021b). While the amendments continued to intend to prohibit GGE for clinical applications, they also introduced pathways to enable research involving GGE to be permitted. Since 2015, when GGE became a more tangible possibility, there has been intense and ongoing debate on whether GGE for clinical applications should be permitted in the UK and across the globe (World Health Organization, 2019).
In 2017, the American Society of Human Genetics (ASHG) published a position statement which was approved by its workgroup. The workgroup included representatives from Asia, Asia Pacific, Australia, Canada, Southern Africa, and the UK (Ormond et al., 2017). This statement was thought to be a shared global stance. The statement indicated that there was consensus on GGE not being ready for clinical application. However, in 2018, the techniques were prematurely and unsuccessfully used in China on human embryos (Lovell-Badge, 2019). There was a significant uproar among professionals from a variety of disciplines and policy officials globally when the research was announced (Daley, Lovell-Badge and Steffann, 2019).
Since the incidence, China has introduced legislation which explicitly prohibits clinical applications of GGE but, like the HFE Act, is still fallible (Song and Joly, 2021; Mahase, 2023). Although any country is yet to legally permit clinical applications of GGE, there are strong indications that in time, some are likely to do so. This is because GGE has significant potential to reduce incidence of monogenic diseases and related disability in future generations and this possibility appears to be highly desired in many countries (Kaur, 2022; Ormond et al., 2017).
Lower incidences of such diseases could reduce strains on national health systems, improve gross domestic product, and of course enhance the quality of life for individuals affected by disease and their carers, the majority of which are usually female (Ormond et al., 2019; Ferrant, Pesando and Nowacka, 2014). This could mean that female biocapital expended on conceiving a child free from genetic disease, or factors relating to disease and disability to rear a child, could be reduced. A leading cause of miscarriages is thought to be genetic abnormalities in embryos (Regan and Rai, 2000); GGE may therefore reduce the incidence of miscarriage and the associated impacts miscarriage has on females and their families.

1.2.2 Ectogenesis

UK law surrounding ectogenesis is complex. This is because there are several scenarios relating to human reproduction in which this technology could be used. In relation to full ectogenesis, i.e. where the embryo would be completely gestated outside of the human body, this scenario could currently be considered under the remit of the HFE Act. However, this scenario, although not permitted, is not technically prohibited either.

In relation to embryos created outside of the human body, as would be required for full ectogenesis, the HFE Act only details what cannot be placed inside a woman. «3 (2)(a) – No person shall place in a woman – an embryo other than a permitted embryo» (Parliament UK, 2008). Like legislation relating to GGE, scientific capabilities in 2008 may have meant that embryos being able to be gestated anywhere but inside a woman was not foreseen. Of course, ongoing developments mean that other possibilities, one of which are artificial wombs, now exist.

In scenarios relating to partial ectogenesis, i.e. where the embryo would first be gestated inside a human body, the law is still complex. This is because such cases are outside of the HFE Act's remit, and other legislation may apply. In scenarios relating to premature birth, ectogenesis may be considered as a therapeutic intervention and to be preferable for the neonate's long-term development in comparison to a traditional air-based incubator. This appears to be the primary line of argument for the development of such technology for human applications (Romanis, 2018, 2020b; Segers, 2021). In such cases, there appears to be no legal barriers.

However, in cases where a pregnancy may be purposefully ended in attempt to place a foetus in an artificial womb, for whatever reason, this is far less straightforward. According to Elizabeth Romanis (2020b, 89), an Associate Professor in Biolaw, there is no right in British Law for a pregnancy to be terminated outside of emergency circumstances. She argues that

> [a] doctor merely has a defence to the crime of procurement of miscarriage under the Offences Against the Person Act 1861 and/or child destruction under the Infant Life (Preservation) Act 1929 in a list of prescribed, and heavily medicalised, circumstances that are listed in section 1 of the Abortion Act 1967 (Romanis, 2020b, 89).

This would mean that the purposeful termination of a pregnancy after 24 weeks gestation, for non-medical purposes, would be considered a crime under British Law.

Across the globe, legislative stances on partial ectogenesis would most likely concur with the therapeutic intervention vs. abortion divide. Hence, depending on law(s) for abortion in a given country, stances are likely to differ. Legislative control over female biocapital and clinical labour is discussed later in this article.

1.2.3 In Vitro Gametogenesis

The novelty of IVG means that the development and use of such cells are not yet regulated by law in the UK. Technically, an argument could be made that once gametes are produced, they would then fall under the remit of the HFE Act. The use of the resulting gametes would then be subject to the provisions in the HFE Act, and equivalent legislation across the globe for the procurement and usage of gametes outside of the human body. However, potential applications of IVG are complex. Thus, this technology should also be regulated. In the UK, amending the HFE Act so that IVG, whether for clinical purposes or research, is encapsulated in the Act's provisions, could be the most logical approach to regulating the technology.

According to Notini, Gyngell and Savulescu (2020, 125), all of whom are bioethicists, applications of IVG could include enabling people who would otherwise lack the capacity to produce functional gametes a means to do so. IVG could also be used to enable postmenopausal motherhood, same-sex reproduction, and solo reproduction (Cutas and Smajdor, 2015; Suter, 2016). Notini, Gyngell and Savulescu (2020, 124) argue that the latter three possibilities «have attracted significantly more criticism». This could mean that some applications of IVG may receive more support than others, and that depending on cultural and political views across the globe, if any clinical applications involving IVG were to be permitted, these may be restricted accordingly.

Procuring egg cells via IVG would be far less invasive than current methods used for IVF; this could make the technology far more appealing to females (Suter, 2016). IVG therefore has the potential to create both positive and negative dramatic shifts in the FMB. Like applications of GGE and ectogenesis, applications of IVG must also be carefully considered so that the benefits and risks of developing the technology are both critically assessed. The next section details why potential risks mean that caution should be extended to the development of RTs.

1.3 Risk Society

Ulrich Beck, a German sociologist, theorised the concept of «risk society» (Beck, 1992). He argued that the distinct prevalence of technological changes in modern societies mean that humans are constantly responding to risks which they themselves have created. Beck (1992, 21) essentially claimed that as society tries to remedy one problem, such as medical and social reasons which impede fertility, society instigates another problem, such as risks stemming from the development and (mis)use of RTs. Thus, societies are stuck in a perpetual loop of creating further risks to solve another. The endless loop is what Beck argues to be the defining feature of «risk society». GGE, ectogenesis, and IVG are examples of this infinite loop. The following sections consider the risks involved in the development and use of the three technologies, and how these could relate to changing the FBM.

1.3.1 Risks associated with GGE

Currently, the advocated primary benefit for the development and potential use of GGE as a reproductive choice, is for the prevention of monogenic diseases. This possible application is widely supported (Kaur, 2021a; Boardman, 2019; van Mil, Hopkins and Kinsella, 2017; Wipperman and Campos, 2016). Such application could mean that female gestation, birthing, and rearing experiences are enhanced, insofar as such experiences may be spared complications and adversity that can be experienced with various diseases. This could mean that females are less likely to have to sacrifice career or life aspirations to mediate caring responsibilities to their child, both of which are encompassed by the labour theory of value, for prolonged periods of time (Cooper and Waldby, 2014). However, while the technology could facilitate these possibilities, GGE could also be used for other purposes.

Applications of the technology not aimed at preventing disease, such as those aimed at inducing aesthetic characteristics receive far less support (Kaur, 2022; van Mil, Hopkins and Kinsella, 2017; Wipperman and Campos, 2016). Additionally, applications could include inducing enhancements such as intelligence, being used for bioterrorism, and preventing minor ailments (Baylis, 2019; Gyngell, Douglas and Savulescu, 2017). GGE has also been at the centre of debates on degrading people with disease and disabilities, and the expressivist objection (Boardman, 2019). Due to the ever-evolving nature of disease and disability, *de novo* genetic diseases, and acquired disabilities, the risk of such possibility is low. Further, the likelihood of such applications are slim (Kaur, 2021a). However, these other applications are part of the reason why applications of GGE must be regulated.

If the technology were ever to be permitted for clinical application, there are also fears that potential parents, particularly females, may feel or be pressured into using GGE, i.e. new forms of clinical labour. Presently, GGE would still be dependent on IVF. The development of this technology could have adverse effects on the FBM, insofar as females may feel pressured into using a technology that could have negative impacts on their health and wellbeing. Research suggests such pressure would also be unlikely (Kaur, 2022), but such ethical matters should not be ignored when considering the risks of GGE.

1.3.2 Risks associated with Ectogenesis

As mentioned above, ectogenesis is currently being developed under the guise of facilitating partial ectogenesis for premature neonates. This application is not particularly controversial. However, applications of the technology extending to full ectogenesis present several risks. First, full ectogenesis could change the FBM by removing the need for surrogates, or any female in totality (Cavaliere, 2020). Full ectogenesis could therefore reduce the risks associated with pregnancy and childbirth (Creanga et al., 2014; Ghulmiyyah and Sibai, 2012; Ronsmans and Graham, 2006).

According to Carine Ronsmans and Wendy Graham (2006, 1189), both British epidemiologists, «[t]he risk of a woman dying as a result of pregnancy or childbirth during her lifetime is about one in six in the poorest parts of the world». Reducing such risk could therefore be considered beneficial. But, some females find fulfilment in bearing children, and some surrogates are dependent on this form of clinical labour, which can nonetheless be very exploitative of female biocapital (Cavaliere, 2020; Jorgensen, 2000; Wilkinson, 2016).

Second, the sensory and psychological impacts that ectogenesis could have on human child development cannot be predetermined. The sounds, feel, and nutrition foetuses experience in utero can create a familiarity that can later be of comfort to neonates (Sander-Staudt, 2006). If a child were to be birthed from an artificial womb, whether partially or fully, their familiarity with their parents' voices, and the noises in the everyday living environment they will be taken home to may be reduced. Similarly, this technology may have negative impacts on parent-child bonding, and immunities usually received from the mother (Sander-Staudt, 2006, 118–121).

Whether these risks could outweigh the benefits that the technology could introduce to reproductive options and the changes that these could establish for female biocapital is therefore worthy of careful consideration.

1.3.3 Risks associated with IVG

IVG perhaps seems revolutionary with very few drawbacks. The former point cannot be denied, but the latter point could be underestimated. Research on the reprogramming of cells indicates that there were several scientific aberrations with such technologies (Ma et al., 2014), some of which may still be unresolved. As mentioned above, there are some potential applications of IVG that receive more criticism than others. The possibility of this technology enabling same-sex reproduction may be very welcomed by same-sex couples who value genetic kinship. This technology would enable both individuals in the same-sex coupling to have a biological relation to their child. Genetic kinship can have profound importance for some people (Franklin, 2013). But, there are people who would not consider this a move in the direction of reproductive justice and in lieu, «unnatural» (Notini, Gyngell and Savulescu, 2020, 128; Suter, 2016). The risk in this context would therefore be developing more technologies which challenge the beliefs of people who hold such views.

The potential for IVG to facilitate postmenopausal motherhood is also contentious, but perhaps more so because of the implications of an older parent rearing a young, usually energetic child, and the greater risk of children being orphaned at younger ages (Cutas and Smajdor, 2015). Yet, the possibility of solo reproduction is perhaps the most scrutinised potential application. This could be because some may think that this is akin to cloning, but the combined gametes would result in genetically distinct products (Notini, Gyngell and Savulescu, 2020). Additionally, while solo reproduction would be new to human reproduction, it is common in other forms of nature. Nonetheless, this application is most likely to introduce harmful genetic mutations (Testa and Harris, 2005).

Similar to the other technologies, applications of IVG appear to be the greatest risk, but could also be carefully regulated. Legislation could detail which applications (if any) to permit or to (continue to) prohibit. However, legislative decisions should be reflective of the overarching views of the societies they serve. There is a growing movement for reproductive justice, particularly for females (Chrisler, 2012; Ross and Solinger, 2017). This movement largely exists because social shifts in cultural norms and values have led to the belief that females should be afforded full bodily autonomy and thus, their biocapital should not be regulated. The next section explores why the risks associated with the detailed RTs may be socially accepted in relation to shifts in cultural norms and values.

2. Social Shifts in Cultural Norms and Values

Stemming from debates on decriminalising abortion, significant attention is being drawn to the fact that in the realm of reproduction, female biocapital and bodily autonomy is still regulated by legislation. The more attention that is drawn to this matter, the more support is elicited for females to regain full bodily autonomy. This is a steady social shift in cultural norms based on the belief that females should be recognised in equal value to their male counterparts (Ferguson, 2019), not as possessions to be controlled by men (Gilman, 2003).

Some countries, such as Canada have already recognised the right for females to have full bodily autonomy, and have already decriminalised abortion (Shaw and Norman, 2020). Such countries may also be likely to permit applications of RTs which could afford greater reproductive justice, particularly for rainbow communities, and people with disease or disabilities. Other countries, where there is less tolerance of diversity in beliefs, opinions, and behaviours, such as the US and those within the UAE, may be less likely to do so (Davis, 2022; Centre for Reproductive Rights, 2022).

Due to such differences in legislation across the globe, people seek and utilise transnational care to fulfil their reproductive desires (Inhorn, 2015). If one of the technologies were to be permitted in any country, an assumption could be made that people who want to access the technology would travel to use it, even if they are not citizens of the country they travel to. The rise and relative ease of transnational care means that national jurisdictions are somewhat limited. Thus, a global approach to regulating applications of RTs is perhaps needed. Nonetheless, consideration can still be extended to the impact these technologies and a non-unionised regulatory approach could have on the FBM.

3. Potential Changes to the FBM

Figure 1. lists key changes to the FBM that could occur if GGE, ectogenesis, or IVG were to be permitted as reproductive choices. The listed arguments are specific to the associated technology.

Germline Genome Editing	▪ Pressure to utilise GGE if known to have a genetic disease ▪ Less females birthing and caring for children with disease ▪ More females subjecting themselves to the risks of RTs ▪ Greater choice for females who may not want to risk having a child with a genetic disease
Ectogenesis	▪ Devaluing of female biocapital and capability in lieu of reverence to technological capacity[3] ▪ Less females subjecting themselves to continuing with high-risk pregnancies ▪ Less reliance on females for gestation ▪ Enabling greater reproductive choice for females who are not able to gestate
In Vitro Gametogenesis	▪ Devaluing of female biocapital ▪ Less females subjecting themselves to the risks of IVF to procure gametes ▪ Greater market for female gametes ▪ Greater choice for females with no or poor-quality eggs to have a genetically related child

Figure 1: Potential Changes to the FBM in the light of GGE, Ectogenesis, and IVG

In addition, to these technology specific potential changes, there are also several overarching possible changes to the FBM that the introduction of these technologies as reproductive choices could evoke. Some of the positive possibilities are that female biocapital, and associated labours, could become less prone to exploitation. The natural capacities of female biocapital could also be given greater respect. Gendered pay gaps which are somewhat argued to exist because of the role female biocapital traditionally plays in reproduction and childrearing practices, could decrease. And, females may be able to plan their life trajectories without factoring in the time and complexities of maternity care.

In counterbalance, the introduction of these technologies could increase social inequalities, insofar as only those with sufficient financial capital may be able to use them, particularly if they are only available through private means. An argument could be made that some charities may support access to the technologies depending on why they are being sought for use, but such access could be dependent on social or cultural capital. Thus, people without these capitals may suffer further reproductive injustices. Additionally, if applications of the technologies for human reproduction were to only be permitted in some countries the cost of accessing transnational care could also further inequalities.

4. Conclusion

In conclusion, a potential future with GGE, gametogenesis, and IVG as reproductive choices could create both positive and negative changes to the FBM. While the introduction of such reproductive technologies could reduce gendered inequalities associated with reproduction, they could also further social inequalities. And, while they could expand reproductive choices for marginalised communities such as those with disease and rainbow communities, they could also further reproductive injustices if such communities were to be denied access to them in their countries of residence. In this context, a globalised approach to the regulation of such novel reproductive technologies may be more ideal but, given cultural differences, could also be very hard to draw consensus on. Research on how a globalised approach could be implemented may therefore not only be a significant undertaking but could also have significant international impact.

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