

# A cold yield. Cryopreserved oocytes of “social freezing” customers as potential option values for biomedical research

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## Abstract

While the demand for “social freezing” services has increased significantly in recent years, the number of cryopreserved eggs that are actually being used in treatment remains very low, so far. Both tendencies indicate a continuously growing stock of unused oocytes. In this article, I discuss the possibility that the growing stock could be co-opted to solve the problem of egg procurement especially for biomedical research. As a consequence, the secondary utilization of female fertility resources would become their main form of use. However, this would finally turn the customers of fertility services into unintended productive forces of a cryotechnologically advanced bioeconomy. The paper discusses the risk of a subtle form of exploitation that could be associated with this reproductive service in the future, which will pose further challenges for the practice of informed consent.

Keywords: Cryopreservation, social freezing, oocytes, bioethics, cryopolitics, cryoeconomy

## Introduction

Since the biotechnical, ethical and legal conditions for cryopreservation of oocytes without a medical indication, also known as “elective” or “social” egg freezing or just “social freezing,”<sup>1</sup> have been largely improved in many countries, the demand for this still new cryo-fertility service has increased significantly. However, recent studies also suggest that only a very small share of cryopreserved eggs are actually used for treatments. If both tendencies persist, they will result in an ever-growing stock of cryopreserved oocytes that will not be used to initiate a pregnancy of those women who decided to undergo a “social freezing” treatment. The question arises: What will happen with this growing stock of these deep-frozen “fertility reserves” otherwise?

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<sup>1</sup> For a critical discussion of the name “social egg freezing” see for example Baldwin (2019, 11–13). Although I share critical objections against this designation, I will stick to this wording in this article, for it has become the most common signifier of the practice in question. The widespread alternative “elective egg freezing” implies a quite deliberative decision-making process, which in the light of my argumentation turns out to be no less problematic than the attribute “social.” However, the latter in turn refers more explicitly to the social conditions of the practice that are of interest here. To handle this term with caution, I always keep it in quotation marks. Regarding the meaning of the term, I would follow Baldwin (2019, 13): “social egg freezing should be conceptualised and understood as a fertility extension technology which conserves genetic relatedness to potentially allow women to partake in the culturally valorised process of family building wherein the reproduction of genetic kinship relations is prioritised and maintained.”

In this article, I will discuss the possibility that a large or even most part of the unused oocytes cryopreserved for reproductive purposes without medical reasons (in the following: “fertility reserves”<sup>2</sup>) will not be discarded, but rather reused for secondary purposes. I will also discuss some of the circumstances that could facilitate, or even make likely, such a development (where not hindered by other factors, e.g. legal restrictions). However, my aim is not to prove the actual probability of such a scenario, in the sense of a prognosis, or to speculatively predict a future trend. What matters to me are the consequences that would result from a *structural coupling* between the probability that cryopreserved oocytes from “social freezing” contexts will not be used for treatments on the one hand and a probability of their second utilization on the other. With such a structural coupling – fostered by technical, social and economic conditions – the objectives of “social freezing” users would ultimately become means to third party ends. Contrary to arguments that second use of “spare fertility reserves” would be ethically unproblematic or even the best possible solution to the problem of “egg shortage”, especially in the context of stem cell research, I will argue that their regular reuse would lead to a de facto instrumentalization of these women, because it would *connect the unlikeliness* of using cryopreserved “fertility reserves” for personal reproductive purposes *with the likelihood* of reusing these oocytes for third-party purposes. In other words: With the use of the cryo-fertility treatment service, most of “social freezing” users could become pivotal labor forces of an emerging cryo-economy – unintentional or even unnoticed by the subjects themselves. Such a development would ultimately amount to a subtle form of exploitation. Thus, I will argue that appropriate precautions should be considered in this direction. As a first practical measure, I will suggest a revision of the practice of informed consent in this context, which so far does not seem to address this risk at all.

My argumentation is tripartite. I will start with an extensive secondary analysis of empirical studies on the use of “social freezing” services and the possible reasons why most of the “fertility reserves” are not used for the intended reproductive purposes. In doing so, I will not provide any original empirical material to this topic, but give a first extensive review of empirical data on the (non-)utilization of cryopreserved oocytes for private purposes so far available. On the basis of this material, I propose the “option value” rather than the “use value” of cryopreserved eggs as an explanation for both their increasing demand and their imminent non-use.

In a second step, I will turn to the question of what will happen to most of these unused stocks in the long term. For this, I will again rely on a secondary analysis of empirical studies on the preferences of women regarding the disposition of their “fertility reserves.” The findings of these studies give reasons to conclude that a significant part of the eggs to be disposed might be donated for research. While data available so far are not sufficient for reliable prognoses, I will discuss further arguments and evidence suggesting that many, if not most, of the unused eggs could actually be recycled in this way – against their primary purpose – as the outcome of a difficult and possibly unpleasant decision-making regarding

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<sup>2</sup> This term, like “fertility preservation,” is strictly understood an incorrect designation, “a misnomer”, as Lauren Jade Martin has pointed out: “Women who use their own thawed eggs because they cannot conceive on their own are no more fertile than those women who use donated eggs for the same reason. What has been preserved is not their fertility, but the genetic connection.” (Martin 2010, 533) The term “fertility reserve” has been introduced by providers of reproductive medical services to promote this technology. I will stick to this term to keep visible the purpose that these eggs are intended to serve.

the disposal of unused “fertility reserves.” The first argument will be that female “fertility reserves” might offer a convenient solution to the long-standing problem of egg procurement, particularly in stem cell research. A second argument will deal from a more theoretical point of view with the technological and economic conditions of the production of cryopreserved biological artifacts (in short: “cryofacts”) and their valorization as “cryovalue” (in difference to “biovalue”).

The proposed theoretical approach to cryopreserved oocytes as disposable potentials for future uses shall help not only to relate the status of “fertility reserves” as “option values” to the general value form of cryofacts, but also prepare the discussion of the normative problems regarding the reutilization of “spare” oocytes as a regular form of their allocation as resources for biomedical research, that I will discuss in a third step: My final argument seeks to assert a risk of a subtle form of exploitation to which “social freezing” customers would be exposed under the conditions in question – a risk that they should be made aware of in due time. To make this point clear again: In doing so, the overarching aim of my argumentation is not to predict that the development outlined above *will* actually take place, but to show why it actually *could* happen, and that the women in question *should* be informed about this possibility before undergoing such treatment in any case. Because the opposite would be irresponsible if not deceptive. My discussion of this possible problem should therefore not be misunderstood as mere speculation about the future of “social freezing”, but as an empirically informed, theoretically based and ethically oriented contribution to a risk assessment of this still new reproductive technology.

## “Still in storage” – the state of research on the utilization of “social freezing”

While absolute numbers of women who started a “social freezing” treatment are still relatively low, they are increasing substantially. Regarding the situation in USA, it has been reported that only about 500 women froze their eggs in 2009, while it was already almost 5000 in 2013, and in 2015 it has been estimated that by 2018 about 76,000 women will have their eggs frozen (Alter, Tsai, and Trianni 2015). Studies for European contexts show more or less similar trends. Cryopreservation of oocytes has been reported as the fastest-growing reproductive medical service with an annual rise in demand with up to 407% within the UK, and even 867% in Spanish clinics (Jackson 2018, 25). Latest official figures from UK’s Human Fertilisation and Embryology Authority (HFEA) have shown that the number of eggs frozen in 2016 for patient’s own future treatment was 370% higher compared with 2010 (Human Fertilisation and Embryology Authority 2018, supplement p.3). The HFEA concludes: “The growth observed in egg freezing has largely been driven by growth in private egg freezing” (Human Fertilisation and Embryology Authority 2018, 12), thus by “social freezing”. With regard to the whole European context, the European Society of Human Reproduction and Embryology (ESHRE) found that in 2013 the number of oocytes cryopreserved in eleven European countries has been 23,655; whereas “the total number of ovarian tissue in Europe is unknown” because “only a few countries collect specific detailed data” on the cryopreservation of oocytes (Shenfield et al. 2017, 2). Nevertheless, the data collected indicate that most of the oocytes cryopreserved in Europe have been retrieved for donation, and the number of cryopreservation activities for non-medical reasons comes close to those for medical reasons: 8826 of the total 23,655 European oocytes cryopreserved in 2013 (37%)

have therefore been retrieved for “social freezing” purposes (Shenfield et al. 2017, 4). Thus, given the expected further growth of this still relatively new sector of ART services, the reported figures give reason to conclude that elective egg freezing contributes to a substantial and increasing share of the total number of cryopreserved oocytes available.

However, the number of cryopreserved oocytes actually being used in treatments is very low. First studies on the intended and actual use of these oocytes indicate that only 0.5–15% of women actually used them for attempting a pregnancy. In 2013, a survey of 183 women who have cryopreserved oocytes in an American fertility center found that only 11 of them (6%) had returned to use their frozen oocytes (Hodes-Wertz et al. 2013). Two years later, three further studies have been published reporting even lower numbers. In a Belgian cohort, 65 women have been interviewed about the use of their oocytes; only two (1.3%) answered that they returned for a treatment cycle, and only a half of them believed that they will ever use their fertility resource (Stoop et al. 2015). In an exploratory study of 23 UK-resident women who underwent a “social freezing” procedure, it has been found that only two of them (0.5%) had used their cryopreserved oocytes (Baldwin et al. 2015). And in a somewhat larger sample of 232 US-resident women storing eggs for at least 2 years in a Californian facility, 220 of them (95%) reported that they still had frozen oocytes in storage; based on further data collected concerning the attitudes and life conditions of these women, the authors concluded that “non-utilization of cryopreserved oocytes is likely to persist” (Myers, Daily, and Jain 2015, e30). This conclusion can be supported by further studies that have been published in the following years: A Spanish study with a sample of 1,468 women who cryopreserved their eggs because of age or having associated a medical condition other than cancer between 2007 and 2015 found that only 137 patients (9.3%) returned to use their oocytes (Cobo et al. 2016). An Australian study reported that only six of 96 surveyed women (6%) had used their stored oocytes (Hammarberg et al. 2017). A binational qualitative study of 150 women who have undertaken “social freezing” in the USA or Israel found that only ten women (15%) had actually used their frozen oocytes – all of them Americans, by the way, none of them Israeli (Inhorn et al. 2018a). And at the 34th Annual Meeting of the European Society of Human Reproduction and Embryology in 2018, a study has been presented which has recorded the experience of 563 women who cryopreserved their eggs in 2009–2017 in one of Europe’s largest fertility centers based in Brussels; only 43 of them (7.6%) reported that they have returned to the clinic for treatment (EMJ Repro Health 2018; Cha 2018). This trend can be confirmed by the 2018 HFEA report: “There are fewer egg thawing treatment cycles than there are egg freezing cycles, suggesting that although more women are freezing their eggs, many of them have not yet decided to try for a pregnancy” (Human Fertilisation and Embryology Authority 2018, 10–11). Even though more eggs are being thawed in UK for treatments each year (16% increase from 2015 to 2016), only 35% of all oocytes thawed are patient’s own eggs, the rest are donor eggs. HFEA concludes: “We will likely continue to see increases over the next few years in the number of women using frozen eggs in treatment.” (Human Fertilisation and Embryology Authority 2018, 11). However, thawing cycles of patient’s own eggs account for less than 14% of freezing cycles in 2016 – which is roughly a 1:7 ratio. Thus, if we consider the different increase rates (see Figure 1), we may expect that the ratio between freezing and thawing cycles will become even worse in future.

**Figure 3: Treatment numbers for freezing and thawing cycles**

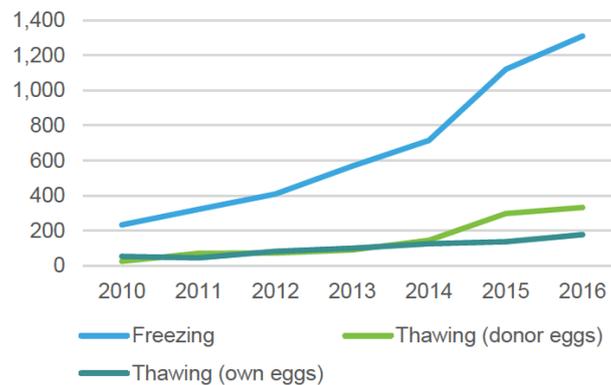


Figure 1: Freezing and thawing cycles in the UK. *Human Fertilisation and Embryology Authority. 2018. Egg Freezing in Fertility Treatment. Trends and Figures: 2010–2016. London: 10. 5.*

Now it could be argued that the obvious disproportion between freezing and thawing cycles, indicating minimal usage rates, can be explained by the fact that it is still too early to know when people will (or will not) return to their eggs, since the practice itself is still quite new and thaw rates might increase as times go by. While this may prove true in future, more recent studies just confirm the previous pattern. A 10-year retrospective analysis of clinical records of 129 patients in two UK fertility clinics who returned to thaw their eggs between 2008 and 2017 states that: “We were particularly struck to note that while social egg freezing (SEF) accounted for 75.7% of the freezing cycles in that dataset, it only corresponded with 14.9% of cycles in which eggs had already been thawed to attempt conception.” (Gürtin et al. 2019: 1070). A related 5-year retrospective analysis of clinical data of 352 women of a UK fertility clinic reports that:

the typical patient who has frozen her eggs for “social” reasons, [...] is very likely to still have her eggs in storage (even if she froze up to 5 years ago). [...] almost all of the eggs from SEF cycles (92.8%) between 2012 and 2016 are still in storage. (Gürtin et al. 2019, 280).

Looking back, on a sample of 31 early adopters in the UK and US who underwent a “social freezing” treatment between 2005/6 and 2013, nothing seems to have changed since then: “the majority of the women ( $n = 27$ ) had not yet used their eggs in further fertility treatment” (Baldwin 2019, 125).

In sum, this review of the state of available empirical research on the use of cryopreserved oocytes for non-medical reasons indicates that ever more women freeze their eggs but only a few (maximum 15%, on average less) actually return for their “fertility reserve” to attempt a pregnancy. If this is true, then the total stock of “social freezing” eggs is substantially growing but the major part will not serve the expected reproductive purpose. Rather it seems that most of these eggs are about to remain idle resources – kept in hibernation for an uncertain destiny.

Provided that the assessment in the previous section is correct, then a number of questions arise, including the following:

**(Q1)** Why does only a *minority* of women actually use their cryopreserved fertility resources for reproductive purposes?

(Q2) What will happen with the *majority* of the unused oocytes?

(Q3) If the majority of cryopreserved eggs will be used for other than reproductive purposes which they are supposed to serve, should we recognize and advocate a secondary utilization of “fertility resources” as their potential primary use?

## Ad Q1: What are the reasons for the non-utilization of cryopreserved oocytes?

While the number of studies on women who pursue oocyte cryopreservation as a way to preserve their biological chances to start a family later in life is increasing, still little is known about their reasons not to use their “fertility reserve.” We have “no long term follow-ups that explore the reasons why women may never use their eggs” (Gürtin et al. [2019](#), 1070). Most of empirical data on egg freezing come from clinic-based research. Fewer, but a growing number of studies have been undertaken by social scientists who qualitatively examined women’s motivation and experience with oocyte cryopreservation for non-medical reasons. Generally, more information is needed to answer question Q1 sufficiently. However, studies undertaken so far found quite in agreement that the lack of a partner respectively the absence of a suitable co-parent is the most dominant reason for using “social freezing” services in the first place (Hodes-Wertz et al. 2013; Waldby 2015a; Waldby 2015b; Myers, Daily, and Jain 2015; Stoop et al. 2015; Baldwin 2017; Hammarberg et al. 2017; Inhorn et al. 2018a; Inhorn et al. 2018b; Baldwin and Culley 2018; Baldwin et al. 2018; Baldwin 2019; Inhorn et al. 2019; Waldby 2019). Some of these studies have asked women who still keep their oocytes in cryopreservation why they have not yet used them for getting pregnant.

An early US study reported, that some of these women found another way to start a family; others changed their minds about parenting, and some have grown too old for using their oocytes (Hodes-Wertz et al. 2013, 1347). In Belgium, a cohort of women have been asked what they expect about the future use of their oocytes for which they have not returned yet and only half of them reported to believe that they will ever use them at some time; nearly a third didn’t believe that; and one of five was unsure about it (Stoop et al. 2015, 342); the researchers concluded that this cohort “decided to cryopreserve oocytes primarily as a possible insurance against future infertility and to buy time to find the right partner” (Stoop et al. 2015, 343). A study of a UK cohort that has not returned for her oocytes found that most of these women were still looking for “a stable relationship with a partner who they felt was committed to having a child” (Baldwin et al. 2015, 243) and only a few of them had started to think about pursuing single motherhood. More recent studies show similar results. About a sixth of the respondents in a US study became parents by other means, almost a third felt not yet ready for children, and half of them reported the “continued lack of a partner as the reason for non-utilization of cryopreserved oocytes” (Myers, Daily, and Jain 2015). Asked to choose from a list of possible reasons why they had not used their oocytes, the three most common answers of the responding women in an Australian study were: “not wanting to be a single parent, preferring to conceive naturally and not wanting to use a donor sperm” (Hammarberg et al. 2017, 578). More recent studies confirm these findings (Baldwin et al. 2018; Baldwin and Culley 2018, 2019; Inhorn et al. 2018b, 2019; Waldby 2019). Thus, according to previous empirical research, the

persistence of living conditions that motivated the use of “social freezing” services in the first place, namely the lack of a suitable partner committed to parenting in a nuclear family, respectively the reluctance to pursue single motherhood or alternative ways of life, seems to be the dominant reason for the non-utilization of cryopreserved oocytes.

Further studies tried to take a closer look at the preconditions of this cause. Especially two aspects have been discussed in this context: the ideologies of parenthood and socio-demographic problems that are related with the “lack of the partner”-problem.

While the significance of this problem already refutes the prejudice (mostly spread by media coverage on this topic) that “social freezing” customers would deliberately *postpone* motherhood or *delay* childbearing in favor of pursuing her individual career, thereby rejecting social norms related to the ideal of parenting for selfish reasons, interviews of these women suggest, that it is precisely the same ideal of parenthood that has shaped their decision to use this reproductive technology at all; insofar as this ideal implies: (1) the *conviction* that mothering would require to place the child’s well-being ahead of their own; (2) the *expectation* that the future partner should not only be someone with whom it would be possible to start a desirable and stable relationship but also someone who would be committed to fatherhood and exhibit certain cultural values associated with parenting; and not least (3) the *preference* to share with their future partner a genetic relationship with their future children. (Baldwin 2017, 2019). However, although these women intend to “mother intensively alongside a committed male partner”, an unfortunate “disjuncture between the conditions they felt were ‘right’ to pursue motherhood and their own personal circumstances” (Baldwin 2017, 9) prevents them from acting according to this ideal.

In a *binational analysis with global implications* (Inhorn et al. 2018a), these circumstances have been specified as “socio-demographic disparities” of well-educated women in their late 30s struggling to find a suitable partner who matches her social and educational status, meets their expectations for egalitarian partnerships and is committed to similar interests, life goals – and fatherhood, of course. Based on these findings, this study concludes that the decision of these women to cryopreserve their oocytes

appears to be a technological concession among highly educated professional women who are grappling with gender-based socio-demographic disparities well beyond their individual control. [...] Thus, these women’s childlessness is undesired and circumstantial, rather than the result of intentionally fertility “postponement” and reproductive “choice”. (Inhorn et al. 2018a, 9).

More recent publications (Baldwin 2019, Inhorn et al. 2018b, 2019, Waldby 2019) supplement these findings to a quite coherent picture. According to this, it can be stated that empirical research on this topic has substantially identified the continuing, demographically conditioned “lack of partner” problem as a major reason why oocytes that have been cryopreserved for private purposes remain unused.

However, further reasons have been made visible in these studies that indicate a weaker certainty about individual intentions regarding future motherhood. A good example may be the following:

[Some] participants were less convinced about the role motherhood would play in their lives and instead questioned whether their feelings with regards to motherhood stemmed from their own personal desires or from social expectations: “I have even thought recently: do I actually even want to have kids anymore? Am I just, are we just intellectualising this and leaving doors

open because they are there?” (Johanna 42, Single, Non-Mother) “I really had to think about, well is this something that I just think I want to do because that’s what I think I’m supposed to want to do, or do I actually want to do this?” (Katie 38, Single, Non-Mother). For these women, it appeared that egg freezing allowed them to retain the option of motherhood in the future should their ambivalent feelings change but also in the case they met a partner who wanted to become a parent. (Baldwin 2017, 5.6–5.7)

In such cases, the reason for starting a “social freezing” procedure, would not be *to postpone a planned pregnancy*, but *to keep the option open to decide for or against biological motherhood* – an option that would otherwise vanish inevitably with the process of aging and the loss of fertility.<sup>3</sup>

Buying time and retaining options are not the same kind of choice, and they may lead to different consequences: If we buy time for a certain end, the investment will be in vain, if the aim fails. But if we invest in options that we want to have at our disposal, then we will extend our scope of present possibilities, even if we never realize them. In the latter case, “social freezing” would serve more as a sort of “decidability assurance” rather than as a “fertility insurance” as it has been labeled – and criticized – so often; or in other words: “Rather than providing insurance against future infertility, it might then be more accurate to say that egg freezing offers insurance against future *regret*” (Jackson 2018). With the availability of an option, the possibility of self-blame is given, if the option would be left unused. Several studies indicate that the fear of future regret and self-blame is indeed a strong motivation for many women to undergo “social freezing” treatments (Baldwin and Culley 2018, 3; Baldwin 2019, 89). In this case, oocyte cryopreservation would rather be a technology *to avert the anticipated loss of remaining options* than a technology for *postponing the realization of an intended aim*. Insofar it is correct to say that: “To describe women who would like to have children at some point in the future but not at present as *postponing* misreads their intention as necessarily aiming for current conception and childbearing” (van de Wiel 2015, 125; my emphasis). However, we would in turn misunderstand this forms of doing “social freezing”, if we would describe them as an “end in itself” (van de Wiel 2015, 127; Baldwin and Culley 2018, 4) instead. Even in this cases, the “fertility reserve” still serves as a *means*, not as an end – but it takes on the shape of a peculiar value form: Whether as a means of dealing with the “lack of partner” problem or as a “decidability insurance,” in each case the “fertility reserve” serves as something that can be regarded as an “option value”<sup>4</sup> insofar as for these women the value of their cryopreserved oocytes does neither consist in their *actual* utilization (use value) or its postponement, nor in their (economic) value as a commodity for exchange purposes, but in the safeguarding of their future availability for *possible* uses.

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<sup>3</sup> Incidentally, the anticipation of infertility has, for other reasons, led in China to the analogous practice of a “social freezing” of sperm, as Wahlberg (2018, 87) has observed: “Yet as we can see here, freezing of sperm is an option for men, married or not, who are advised by the sperm bank in its brochure to “anticipate infertility” (Martin 2010) in the face of risks that dangerous or toxic occupations might impose on them or because they are deferring reproduction.” In China, banked sperm is regarded as a “national fertility reserve.” I thank the anonymous reviewer for this insight.

<sup>4</sup> The concept of “option value” has been introduced by Weisbrod (1964). Since then, different meanings of the term have been discussed and come into use (cf. Smith 1983; Riddel and Douglass Shaw 2003; Greenley, Walsh, and Young 1981; Freeman 1985). I will use the term according to (Hubig 2007, 142 and Alpsancar 2017, 431), referring to the future availability of a good.

As option values, cryopreserved oocytes preserve options for potential future actions that will the more likely get lost the more time passes; and they allow present action by relieving time pressure which may result in undesired behavior such as an unwise choice of a partner due to the feeling of running out of time (Baldwin 2019, 85; Waldby 2019, 157). The cryopreservation of oocytes as a means of reducing a perceived pressure to act is still a means, even if or *precisely by* not being used. Thus, the role of “fertility reserves” as “option values” may give us an instructive answer to our first question.

## Ad Q2: What will happen with the unused cryopreserved oocytes in the long term?

Once it is clear that the saved options cannot be realized anymore (which may depend on social, biological, economical or emotional circumstances), the “fertility reserves” lose their purpose as “option values” for fertility treatments – and a decision has to be made: Given that the oocytes cannot be stored indefinitely (more for legal and economic than for technical reasons), they have to be disposed of someday – unless other options of utilization come up for election. The same applies for leftover eggs of a successful treatment. In general, there are three possible options and two modes to deal with “spare eggs”; all of them are discussed controversial, depending on national legislation, social norms, religious attitudes, moral convictions, and so on. These options are (1) to *discard* “spare eggs;” (2) to make them available to other women *for treatment purposes*; (3) to make them available to biomedical labs *for research purposes*. And the two possible modes for the last two options are: either by selling or donating them. Regardless if leftover or unused: These oocytes will be faced with at least one of these options and could be faced with all of them. In any case, they will be subject to a decision concerning their *disposal* – in the ambiguous sense of the term: *dispose of waste* or *dispose of goods*.

From a legal point of view, it has been stated that: “Women banking eggs are the owners of them, and will have ultimate dispositional control over them until they choose to transfer that control to another. How they will or should exercise that control is the question.” (Robertson 2014, 123) The question of how decisions about the disposition of egg cells are made is ultimately an empirical one. In the following, I will briefly discuss the results of studies that could provide some initial insight into this matter, before I come to the technical conditions, economic contexts and theoretical implications of disposition control that should be considered in a discussion of the normative aspects of their exercise.

### Possible preferences for the disposition of “fertility reserves”

To answer the question of the actual exercise of this “ultimate dispositional control” empirically, there are only a few data available so far – which are for the most part based on information about attitudes and intentions, which, of course, are not necessarily consistent with the final decisions. Additionally, we may rely on studies about preferences for the disposition of “surplus” or “spare” embryos from IVF-treatments, the results of which, although not entirely applicable to decisions concerning the disposition of oocytes, can provide some further insights. All these studies suggest that the decision-making process for women is associated with a number of difficulties and inconveniences that render a

donation for research purposes more likely than the discard option, but also than the donation for reproductive aims of other women.

In a Belgian study of a sample of 15 women with cryopreserved oocytes, it has been found that 46.7% of these women would donate them for research if they would no longer need them, 13.3% would donate them to another woman, 26.7% was unsure about their destination (Nekkebroeck, Stoop, and Devroey 2010). In a US-survey of 183 women (Hodes-Wertz et al. 2013), 63% of the participants indicated that they would be willing to donate their unused oocytes to research, followed by 18% wanting them discarded, while 11% were willing to donate oocytes to a fertility clinic. In a sample of 23 UK-women, 88% stated that they would donate not required eggs to research or to other women; however, since Human Fertilisation and Embryology Authority set the upper age limit for donating eggs to the fertility treatment of others to 35 years, only 3 of them would be eligible to do so due to their age at the time of cryopreservation, thus donation options would be reduced to research (Baldwin et al. 2015).

Similar findings have been reported in international studies on the decision-making about the disposition of embryos cryopreserved for in-vitro fertilization treatments, suggesting a positive trend in donation for science (Provoost et al. 2012). It has been found that the apparent preference of women for research donation is conditioned by (a) the possibility of avoiding the discard option, (b) a discomfort with the knowledge of some genetic offspring growing up in an unknown family, connected with the option of donating to another couple, and (c) the wish to give something back to the field of science that helps them to have their children (Mertes et al. 2012; Cooper and Waldby 2014; Cattapan and Doyle 2016; Zimon et al. 2019). However, studies also indicate, that for many women it is often not clear what “research” would mean in this context – some assume that it refers to some kind of medical training. It is often reported that women are not sufficiently prepared for this decision, which is all the more difficult and often reported as distressing as long as the original purpose of the eggs has not been achieved. In the context of “social freezing” it has been found that the “overwhelming majority (87%) of women asked [...] stated that they would donate their unwanted eggs to research or to other women.” (Baldwin 2019, 126).

Although the complexity and also the factual outcomes of the decision on the disposition of cryopreserved oocytes still require further and more detailed empirical investigation, studies available so far indicate that most women confronted with the decision on the disposition of their eggs would favor a donation for research. If we link this consequence to the previous finding that the most of the cryopreserved eggs are unlikely to be used for private reproductive treatments, we can conclude that, given this dispositional option, many, if not most users of “social freezing” services could end up as egg providers for research – which is certainly not, what they initially intended. In the next step, I will shift the focus from the supply side to the demand side of this potential economic relationship to provide further reasons to support this conclusion.

## The “egg shortage”

Human egg cells are a valuable commodity for which there is great demand – a demand which has arisen not before there has been the possibility of satisfying it. This possibility has been enabled by the development of reproductive medicine techniques for ex- and reimplanting human oocytes, and by the development of cryopreservation as a fundamental

biotechnology that has become more reliable and available through enormous progress in the fields of engineering and cryobiology within the last decades. Two aspects shall deserve more attention in our context: the *nature of the value* of oocytes and the *fundamental role* of cryotechnology.

Regarding the value of oocytes in terms of their demand, it is helpful to have a look at the situation before the “social freezing” boom. Already in 2005, 90% of the 1685 fertility clinics in the UK reported an “egg shortage” regarding egg donations for reproductive purposes (Echlin 2005; Sexton 2005, 3). The situation is similar in other countries where egg donation is allowed. Thus, the question arose how more women could be persuaded to become egg provider – despite the complications and risks that come with such a procedure. The means of persuasion are in general moral appeals and financial incentives. Until now, none of them provide an ethical convincing and economically satisfying solution for the problem of “egg shortage”. In fact, the shortage led to a highly stratified market situation with high prices for elite or premium eggs on the one hand and a high exploitation of precarious clinical workers on the other (Waldby 2015b).

Moreover, this shortage has been even increased further by the demands of the growing biotech industry. Especially, human stem cell research involves the procurement of oocytes. In somatic cell nuclear transfer (SCNT) operations, for instance, female germ cells are used for accessing the so-called *pluripotency* of cells. This is the ability of certain stem cells to differentiate in any desired type of somatic cell. This ability is associated with far-reaching prospects in the emerging field of regenerative medicine (Parry 2004, 409). As “future possibilities of differentiation always exceed the finite possibilities available to the developed organism” (Cooper and Waldby 2014, 114), it is the *option for potential future purposes* which constitutes and increases the demand for pluripotent cells.

### The value of “cryofacts”

At this point, I would like to return to the more theoretical question concerning the nature of the value of cryopreserved eggs. Our answer to the first question (Q1) has shown that the value of frozen eggs can be identified as an optional value based on the possibility of transforming it into a use value, which in this case would mean using the oocytes for treatments. With regard to further uses, a wider spectrum of possible use values comes into play including fertility treatment of other women and stem cell research. It has been suggested that this type of value formation should be considered as *biovalue*: “Biovalue refers to the yield of vitality produced by the biotechnical reformulation of living processes.” (Waldby 2002, 310) Such a “yield of vitality” may result in pregnancies (of first or third parties), or stem cells which in turn may result in new tissues or organs that can heal diseases, regenerate damaged or ageing bodies (of first or third parties) or improve their vitality and health. With this (possible) potentiality, stem cells can be regarded as option values itself but since the conditions of their transformation into actual use values (“yield of vitality”) are not guaranteed yet, they are *possible* biovalues and thus *potential* option values. Cryopreserved oocytes again are specific option values, but they can also serve as possible sources for potential option values. I suggest calling this cascading progression of possibilities “potentialization” and to consider cryotechnology as the technological basis of this valorization process.

Cryopreservation is an indispensable technology without which biotechnological research would not be possible. In this sense, it can be understood as a fundamental “research technology” (Shinn and Joerges 2002) of life sciences and modern medicine. Cryopreservation produces entities of a very peculiar nature: biotic artifacts that have been transformed or transposed into a mode of existence right *between* life and death. These entities represent a third state between animate and inanimate nature that has come to be called, “suspended animation,” “cryostasis” or, “latent life” (Luyet and Gehenio 1940; Keilin 1959; Radin 2017). Objects in this mode of existence we may call “cryofacts”. This term refers to the concept of “biofacts” denoting “biotic artifacts” as “man-made things that grow,” such as genetically modified organisms or crop plants (Karafyllis 2003; 2007). In contrast to biofacts, cryofacts are not “things that grow,” but things that *may* grow; and for this possibility they are precisely *prevented* from growing – as from aging and dying as well. Cryofacts *keep* options of becoming; options that living entities *realize* or *lose* irreversibly during their life cycles, since life is perishable. Cryopreservation is thus a technical negation of the self-negating nature of life. Transformed into stabilized perishables, cryofacts can be regarded as cold based option values that save possibilities of life for potential future uses. Therefore, we may say: If “biovalue” refers to the “yield of vitality” produced by the biotechnical reformulation of living processes, then the “yield of optionality” produced by the cryopreservational suspension of living processes is the “cryovalue” of biotic artifacts.

Cryovalue can be converted into biovalue by thawing and using the frozen biota for specific purposes, but the yield of optionality typically exceeds the intended uses of cryofacts due to its potentialization. History has shown – and the practice of modern cryobanking has been built on conclusions from this – that biological artifacts, once cryopreserved, remain available for possible future purposes still unknown at the moment of their transformation into cryofacts. Cryopreserved blood specimen, for instance, that have been collected in the 1960s with the purpose to save the genetic heritage of endangered indigenous people, was used later for studying the past condition of microbes, Malaria for example, that have been unwittingly included in the blood samples before they have gained antibiotic resistance (Radin 2017). Or the genetic information from anthropogenic blood samples was used for anthropological studies on the evolutionary relationship between different ethnic groups (Kowal and Radin 2015). By the same token, cryopreserved oocytes can now be considered as potential resources for stem cell research – which is in itself a project of creating potential option values for future “yields of vitality.”

However, far from neutrally denoting an objective ontological quality, “potentiality” is a concept with which social expectation and normative claims are associated, in the sense that “the ascription of potential depends on what is understood as both feasible and desirable” (Taussig, Hoeyer, and Helmreich 2013, S7). The normative claims imposed by this ascription may then work as “vehicles for politics” (Taussig, Hoeyer, and Helmreich 2013, S5). The form of politics at stake here may be identified as “cryopolitics.” As a modification of the Foucauldian proposition of the “biopolitical” maxim “make live and let die” (Foucault 2003, 241), the concept of “cryopolitics” has been suggested for describing a cryotechnological mode of governing life which follows the maxim: “make live and do not let die” (Friedrich and Höhne 2016; Radin and Kowal 2017). However, with regard to the “yield of optionality” achieved by cryopreservation by suspending “life” for the sake of potential future uses, it seems reasonable to modify the maxim even further with regard to its modal direction: “make *life possible* and *not* let die” (cf. Friedrich and Hubig 2018). In this sense, the extended

concept of “bioavailability” – denoting the status of being “available for the selective disaggregation of one’s cells or tissues and their reincorporation into another body (or machine)” (Cohen 2008, 83) – may be adopted here as well. Cryopreservation can thus be regarded as a means of cryopolitics *to make life possible by making living matter available to potential future purposes*. And as we have found in the previous section, it is the *option for potential future purposes* which also constitutes and increases the demand for pluripotent cells.

### “Spare eggs” for research purposes

As long as alternative methods of stem cell procurement, such as induced pluripotent stem cells (iPS), do not prove to be better, research on the desired control of “pluripotency” will continue to focus on access to high quality female reproductive cells and tissues. However: “Where are all the required oocytes coming to come from – or rather from whom?” (Sexton 2005, 2). – With this question we will return to the supply side of the “egg shortage” problem as it prevailed before the “social freezing” boom.

Women have shown very little motivation to expose themselves to the stressful and risky procedure of egg harvesting just for the sake of science (Waldby 2008; Waldby 2019, 163, 171). In addition, remuneration for research-related donations is contested or illegal in many countries – just as it is the case with reproductive-related donations. The overall concerns here are that financial incentives could commodify human life and encourage women to risk their health either for altruistic or economic reasons, while the gift system often means that donors get exploited as open sources of biological material ready to be privatized by biotech-companies (Sexton 2005; Waldby and Mitchell 2006; Dickenson 2007; Waldby 2015b).

Thus, neither the sale nor the gift model of egg exchange is able to provide a convincing and satisfying solution for the problem of “egg shortage.” Therefore, other ways to procure oocytes for research purposes are being sought. One of them is called *egg sharing*. It offers women to offset the costs of retrieving and storing their eggs if they agree to donate some of them. In 2006, for example, a oocyte-sharing program at UK’s Newcastle University was approved in which IVF patients may agree to donate half of their oocytes for research in return for a 50% discount on their IVF treatments (Haines, Taylor, and Turkmendag 2012; Mertes et al. 2012; Braun and Schultz 2012; Waldby 2019, 177). Similar ideas have been developed in California, but payments for research-related donation are not allowed there – just as it is the case in most European nations – and a discount would be a sort of indirect payment. Thus, it has been observed a tendency towards “crypto-commercialization” of research donations, which however has not proved to be an optimal procurement strategy (Braun and Schultz 2012).

Apart from legal complications, studies on the procurement of oocytes or embryos from IVF patients have shown that moral dilemmas also arise for medical practitioners in fertility clinics, who have the task of passing on the interests of researchers to patients and consider when it is justified to ask women whether they would like to donate their eggs or embryos to research although they may still need them for treatment (Svendsen and Koch 2008). In this context, it has been shown that the concept of “spareness” is less based on biological facts than on complicated considerations on “possible objects between couples in fertility treatment, stem cell researchers and future need of regenerative medicine.” (Svendsen and

Koch 2008, 94). Thus, results of various studies in this field suggest that on the one hand “women engaged in the demanding process of IVF are unlikely to classify their precious eggs as spare” (Waldby and Carroll 2012, 526) without further measures, and that “research is very unlikely to be satisfied with ‘spare’ oöcytes” (Braun and Schultz 2012, 19) on the other. Therefore, ways were sought to release or loosen the “IVF – stem cell interface” (Braun and Schultz 2012).

Against the background of this intricate set of problems, “social freezing” might open up a new, more frictionless and prospering way of oocyte procurement, since the ever-growing stock of “spare” eggs downright seems to be made for solving virtually all ethical, logistical, legal and even financial problems related to oocyte donation at one stroke: for it provides a resource that has neither been prepared nor paid to be left to research, but remains disposable for the main part – while the procurement costs have already been paid by the donors themselves in many if not most cases. For this reason, it has been expected that if the option is presented, many of the “social freezing” oocytes will be directed to research. When the “social freezing” boom just started, this expectation has been formulated in a *Human Reproduction* research paper on the *Implications of Oocyte Cryostorage for the Practice of Oocyte Donation*. This paper concludes that:

these new kinds of donations will put an end to most, if not all, of the practical hurdles and ethical concerns regarding oocyte donation for research purposes, even the issue of financial reimbursement. Thus, the ongoing ethical debate surrounding “research donation” may finally be quelled. (Mertes et al. 2012, 2892)

Based on the findings and arguments that have been discussed in the sections above, the author’s prognosis concerning the “practical hurdles” can be supported – but what about the “ethical”? Here, we finally come back to the third issue raised at the beginning of this paper:

### Ad Q3: Should we recognize and advocate the secondary use of female fertility resources as their potential primary use?

If the demand for “social freezing” treatments continues to *increase* but the rate of eggs being thawed for the intended treatment purposes continues to *stay very low*, while the growing stock of spare eggs is increasingly being made available for research purposes, then the encouraging of women to do “social freezing” might finally amount to turning most of them into unintended egg providers. Or with other words: If such a development would gain ground on a large scale, it would tacitly shift the economic role of most “social freezing” users from customers to producers. This transformation could take place tacitly insofar as the actions and modalities of being a “social freezing” customer and those of being a cryo-economical egg provider could converge even without being noticed by the women involved.

It has already been observed “how *clinical consumption converges more and more with production*” (Cooper and Waldby 2014, 227; original emphasis). Regarding “social freezing” this would be the case as soon as a structural coupling between a *probable non-utilization* of the oocytes for their intended reproductive purposes and a *probable reutilization* of them for a research purposes will have been established. Such a structural coupling might put an

end to the practical hurdles for solving the “egg shortage” problem, indeed. But contrary to the conclusion of Mertes et al. (2012), such a relation would provide a good reason why the discussion of ethical issues surrounding “research donation” may not be “quelled” in this case. Moreover, it should be extended, insofar as the supply of disposable oocytes must be regarded as a production of goods – respectively as *clinical labor* (Cooper and Waldby 2014); a form of labor, however, which is at particular risk of being exploited in a subtle way.

In the last part of this article I will first substantiate the claim of this risk of subtle exploitation and finally make a proposal to make this risk at least transparent so that subjects involved may decide better informed and more autonomous.

In order to make the relevant problem clearer, I will start with an unproblematic case. Under the conditions that a good has fulfilled its task and is then no longer needed, further exploitation in the sense of its meaningful conversion might be a good or even the best option (with final disposal as the worst). Second-hand articles or recycled waste are our most catchy paradigms for this unproblematic case.

However, problems will arise under the condition that (1) the goods in question would never fulfill their originally intended purpose  $\alpha$ , i.e. that they would not be used in the manner for which they were produced and sold, while at the same time it is known that (2) these goods will probably end up being used for a completely different purpose  $\beta$ , for which they in turn represent a required means. Consequently, the provision of the good for the unfulfilled purpose  $\alpha$  would be a necessary means to achieve purpose  $\beta$ . Then, however, one can no longer speak of a mere subsequent recycling, but of a process of allocating resources, constituting a value chain. Seen from the result of this value chain, the producers of means for end  $\alpha$  would ultimately become producers of necessary means for end  $\beta$  – an end that they do not intended, the achievement of which, however, require and depends on their labor. Such a connection would in any case be problematic if the producers in question were unaware of their actual cryo-economic role in this (prospective) value chain. Such a production relationship would be all the more problematic, the more difficulties are involved that women would not take on for the purpose  $\beta$  alone. In this case, it would be justified to speak of a subtle form of exploitation, even when such exploitation were not the result of a calculated strategy, but merely the result of an allocation of co-opted resources as means diverted from their intended purpose for including them in a value chain.

However, with regard to the option value character of “fertility reserves,” it could be objected that they *actually have* fulfilled their purpose as soon as the “options” they are supposed to safeguard have been vanished, i.e. when the possibility of biological motherhood no longer exists. In this case, the concept of “recycling” would indeed be applicable and “exploitation” no longer seem to be an appropriate description anymore. Yet if we take a closer look, the objection will be less convincing: As cryofacts, the “fertility reserves” have the potential to be preserved *long enough* for biotechnical progress, medical improvements, social or legal changes to subsequently revise their “expiry date” in favor of their owners – if, for example, the prospects of later maternities would be largely improved by reproductive medicine and their possibilities legally extended. However hypothetically thought, such possibilities shall only indicate the *contingency of the conditions* of the “finality” in question, and thus the contingency of the question when the original purpose can be regarded as “fulfilled” – thus, when a “fertility reserve” becomes a “spare” or “unused” stock of oocytes that can be considered for further utilization.

In fact, this contingency is often brought to a “final” decision by given boundary conditions, for example in the form of a maximum period of cryopreservation of oocytes for reproductive purposes. In many countries, this time span is legally regulated.<sup>5</sup> But even where the limit is neither regulated nor fixed and therefore unlimited storage would in principle be possible, other circumstances, for example the storage costs or the age of the owners, have a limiting effect on the storage period. If a decision then is to be made at some point due to external conditions and constraints, then the disposition of the “fertility reserves” will be considered: not because these reserves have “fulfilled” their purpose, but because the *conditions of the fulfillability* of the purpose have been suspended – which is a completely different matter.

Under these circumstances, a third kind of problem may arise, if – imposed by the arbitrary “expiry date” – the “decidability insurance” (serving the purpose to keep options open) turns into an imposition of decision. Empirical evidence suggests that many women find the decision-making process challenging and distressing or even would prefer not to have to decide at all. Under these conditions, we can expect that the choice will be most likely in favor of the least unpleasant option of an inevitable decision rather than in favor of a really wanted one; which should nevertheless be considered a “free” choice. And, as studies so far suggest, the most favored – or better: least uncomfortable – choice tends to be the donation for research, if this option is presented. Women may still decide otherwise, of course, for example in favor of donation for fertility treatment purposes or as donors for mitochondrial DNA (Waldby 2019). However, if the suggested tendency should prevail, the logic of an “decision imposition” (cf. Gehring 2006, 123) may contribute to turn many, perhaps most of eligible “egg bankers” into prospective “egg providers” by utilizing their initial but “expired” purposes as a production means for third-party ends.

As disposable cryofacts, the “fertility reserves” could thereby be transformed from private “option values” into *potentialized* “option values” for biotechnical research. They may then serve as resources for stem cell research to achieve the biomedical goal of controlling the *pluripotency* of stem cells in favor of a future regenerative medicine. They may also be used for other research purposes or biomedical treatments – even those *as yet unknown*. We cannot know what future will bring, but if the technoscientific progress in this field persists, we should be prepared for the emergence of ever new options that may add new surplus value to these cryofacts. In this sense, their intended “biovalue” (a possible pregnancy) would be superseded by their “cryovalue” – a cold “yield of optionality.” Such a yield would then be the product of a value chain based on a form of clinical labor that will be exposed to the risk of a subtle exploitation as long as the involved “egg providers” are not aware of their potential or actual economic role as prospective productive forces in a still emerging cryo-economy.

I regard the risk of this indirect form of exploitation as a main objection that speaks against the view that the second use of “spare” oocytes of “social freezing” customers would

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<sup>5</sup> Just a few examples for national time limits for oocyte storage: Switzerland: no more than 10 years, France: no limit, but “social freezing” is not allowed at all (donation only); Italy: no limits; Germany: not regulated; Belgium: 10 years limit; Spain: depends on medical indication of the physical abilities of women for reproducing; UK: 10 years, USA: no limit; Australia: depends on territory, either no more than ten years or the maximum limit is subject to expert opinions, in any case *infinite* storage is not allowed (cf. Bowen-Simpkins, Wang, and Ahuja 2018; Fässler et al. 2019).

no longer involve any significant ethical problems. Emphasizing a *risk*, I do not claim that this development *will* happen, but only that we have reasons to consider that it very well *could* happen. And *if* such a risk exists, then the precautionary principle requires that appropriate measures should be taken to make it at least transparent so the subjects involved in order to enable them to make their decision better informed – not only and firstly when they are expected to exercise their “dispositional control” but already when they are about to enter the whole production process: *before* the beginning of the fertility treatment.

A first obvious step to approach the problem, would be a revision of the practice of informed consent in this context. It has already been criticized that in the case of “social freezing” the present practice is often insufficient if not deceptive due to a lack of long-term studies about reproductive outcomes and future health risks, but also about the contingencies women would experience during and after the whole procedure (Harwood 2015; Hammarberg et al. 2017; Jackson 2018; Mayes, Williams, and Lipworth 2018). Accordingly, interviewed women complained about a lack of information and data provided by their service providers (Baldwin and Culley 2018). This concerns not only the success rates of fertility treatments but also the possible decision regarding the future disposal of frozen oocytes. While it is already known that this decision is often uneasy for customers to make, given the empirical evidence so far, it will very likely be a decision that *has to* be made by most “social freezing” customers. If that proves to be correct, then their informed consent should be based on the knowledge that they are unlikely to remain the customers they wanted to be, and that their decision might instead be a decision to become an egg provider for the emerging cryoeconomy, once they take advantage of a “social freezing” service. *At least* these women should be aware that they most probably will not utilize their “fertility reserve” and therefore should be well prepared to exercise their “dispositional control” someday.

That doesn't seem to be the case so far. To date, empirical studies of this problem do not exist yet (at least to my knowledge). Therefore, I refer here only exemplarily to the most recent guideline on “Planned Oocyte Cryopreservation for Women Seeking to Preserve Future Reproductive Potential” released by the Ethics Committee of the American Society for Reproductive Medicine (2018). This document recommends that women who wish to have their eggs cryopreserved should be informed about the uncertainties of the procedure with regard to efficiency and long-term effects. It also names areas requiring additional studies. However, to collect and provide data on the prospective usage rates of “fertility reserves” on a regular basis are not among these recommendations.

## Conclusion

The review of empirical research on the use of “social freezing” services suggests that a rapidly growing stock of “fertility reserves” coincide with very low usage rates of these oocytes for fertility treatments, with a maximum of 15%. Empirical findings about the decision-making processes regarding their disposition further suggest that a great part of the unused oocytes could be made available for secondary uses, especially in biotechnical research. Thereby, a supply chain would be established that would turn many, if not most, of the “egg bankers” into “egg suppliers.” Such a development should be regarded as a new form of indirect labor within a still emerging bioeconomy based on the production of

“cryofacts” and their potentialization of “option values.” As long as they are unaware of their potential role in this “cryo-economical” valorization process, the women involved will be exposed to the risk of a subtle form of exploitation, which challenges the practice of informed consent. In any case, women subject to this risk should be informed that, according to current statistics, they will most probably have to make a disposition decision someday and that this decision may conflict with their initial intention; thus the decision may come with unexpected burdens for which they should be prepared. Therefore, further empirical studies on forms of use, practices and outcomes regarding “social freezing” services are necessary to provide adequate information. Moreover, the analysis of the value form of cryofacts proposed in this article suggests more detailed theoretical research on the technological and operational conditions of a still emerging cryoeconomy.

## Acknowledgements

The first version of article has been presented as a paper at the Minerva-Gentner Symposium *Frozen: Social and Bioethical Aspects of Cryo-Fertility* at The Academic College of Tel Aviv-Yaffo, October 1–3, 2017. I would like to thank the participants of this symposium for their valuable feedback and all reviewers of this article for their helpful comments and suggestions.

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