Putting Value on Extracellular Vesicles: Practical Economies of Biomedical Research and Development

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Abstract

Several studies over the years have paid attention to the entanglement of biomedical research and the multiplicity of expectations for scientific breakthroughs and economic gains. However, science and economy are by no means the only values attributed to the biomedical endeavour in an actual R&D project. In this article, we present an analysis of a case we studied in Finland, in which academic and commercial partners jointly studied minuscule extracellular vesicles (EVs) to develop related technologies and explore their commercialisation potential. Thus, we ask, what is the spectrum of value in biomedical R&D? Our analysis highlights that in the rapidly developing, but still immature, scientific field of EVs, the dominant value of the research project are related to the expansion of future possibilities (e.g., funding and collaborations) and the sustainability of research. The subject of our study is a new domain of biomedicine that is quite unexplored in science and technology studies (STS), and our findings contribute to ongoing discussions on valuation and economies related to biomedical R&D. We focus on the multiplicity of value, and, by doing this, critically discuss the mainstream view emphasising the dominance of commercial value.

Keywords: valuation, biomedical R&D, household economy, extracellular vesicles, bioeconomies

Introduction

In this paper, we present a case study on the assumptions of value and value creation (Birch, 2017a; Muniesa, 2017) underpinning biomedical research collaboration in Finland. In such collaborations, academic and commercial partners jointly studied extracellular vesicles (EVs), developed related technologies, and explored their commercialisation potential. EV is a general term for heterogeneous, tiny vesicles released by cells in their extracellular environments (Raposo and Stoorvogel, 2013: 373; Palviainen et al., 2017: 77; Raposo and Stahl, 2019: 509). Vesicles are usually less than 200 nm (see Figure 1), and they carry molecules such as proteins, nucleic acids, lipids, and carbohydrates, as well as RNA, as cargo (Mateescu et al., 2017: 2; Raposo and Stoorvogel, 2013: 373; Palviainen et al., 2020). For example, sweat, tears, urine, saliva, plasma, breast milk, blood, cerebrospinal fluid, malignant ascites, and amniotic fluid contain EVs. In addition, EVs have been identified as potential biomarkers for diseases (Mateescu et al., 2017: 2; Kalra et al., 2012: 2; Elsharkasy et al., 2020: 2). EVs are known to affect the progression of diseases such as cancer because they are able to transfer information between cells and can target specific cells. This opens up the possibility of using EVs both in vaccines and in the delivery of medical substances (Raposo and Stoorvogel, 2013: 380; Mateescu et al., 2017: 2; Saari et al., 2015: 727; Raposo and Stahl, 2019: 509). Interest in studying EVs has grown in recent years.[1]

Studies on valuation (see below) in biomedicine and associated bioeconomy have focused primarily on business and commercial contexts, such as venture capital investing, commercialisation, innovative R&D companies, IPRs, and the nexus between science and industry (e.g., Birch, 2017b; Lee, 2015; Roy, 2020; Waldby and Mitchell, 2006); innovation and industrial policy settings (e.g., Aarden, 2017; Ong, 2016; Tarkkala et al., 2019; Tupasela et al., 2020); patient groups or other 'biosocial' organisations (e.g., Gibbon and Novas, 2008); or infrastructures, such as biobanks (e.g., Beltrame and Hauskeller, 2018; Datta Burton et al., 2021; Timmons and Vezyridis, 2017). Our study on the case of Finnish EV research—a partnership consortium crossing the division between academia and commerce as well as scientific and clinical boundaries—concentrates on valuation within research practices and by hands-on people involved in the project (see Tarkkala and Helén, 2021). We focus on assumptions and expectations about EV value and utility, specifically pinpointing various scientific, clinical, and commercial interests and objectives in R&D work.

We ask *what the spectra of value and valuations are in biomedical R&D*. Studies on topics similar to ours often highlight the commercial aspects of life science or biomedicine, or they emphasise the dominance of economic framing of valuation (e.g., Waldby and Mitchell, 2006; Sunder Rajan, 2012; Martin, 2015; Birch, 2017b). In this paper, we are similarly interested in commercial reasoning and value expectations in the public–private partnership mode we study. We approach this topic through a specific project setting, and we want to find out *whether commercial and economic value creation dominates the objectives of R&D and valuation* (see Muniesa, 2017) *in the Finnish EV consortium*. However, our interest in the role

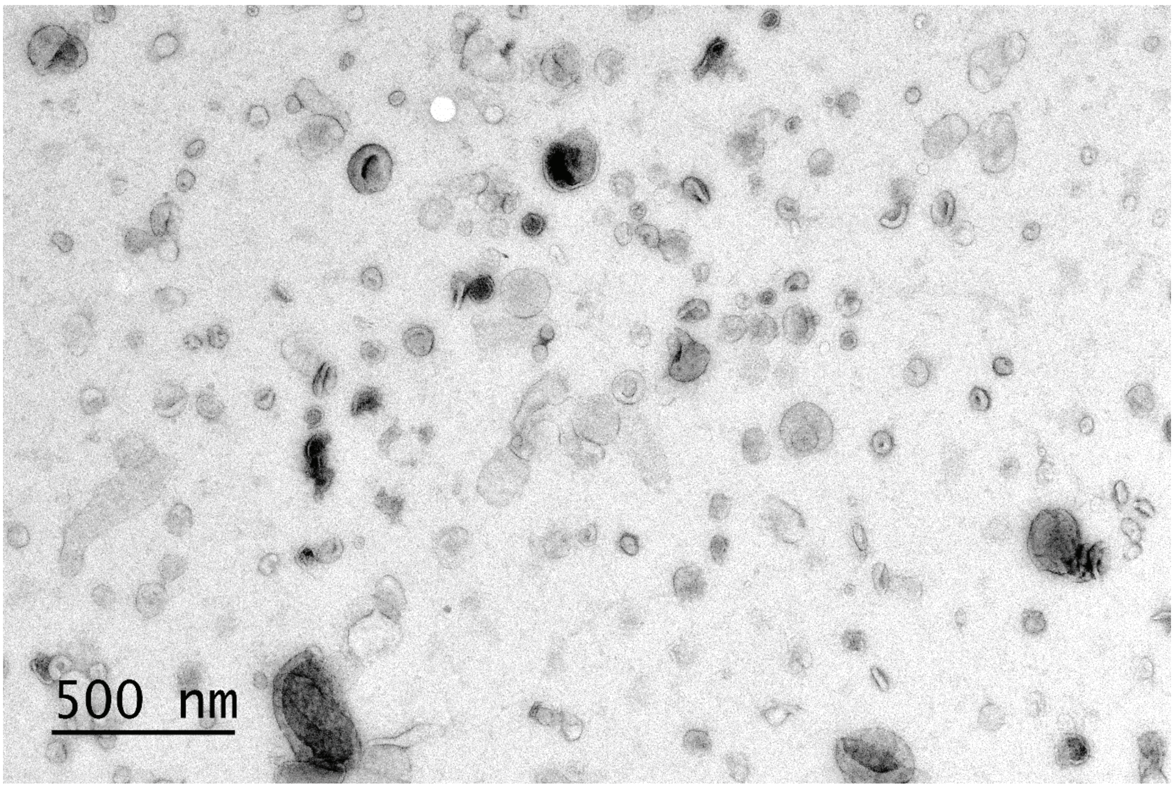

Figure 1. A picture of urine vesicles taken with an electron microscope. Image by Maija Puhka.

and modes of economic valuation is framed in this paper by our primary focus on the presence of value multiplicity among the EV researchers in their practices.

In what follows, we provide the background of our study, namely the context of collaborative science in relation to our case, and the conceptual framing of our analysis. Then, we present our research data and methods, followed by three analytical sections. In the analytical sections, we first present the value of research collaboration as viewed by the consortium partners. Next, we examine the multiple dimensions of prospective value attributed to EVs, as well as their entanglement. Finally, we focus on economic and commercial valuation of EVs and the research in relation to the concerns and efforts on ensuring the continuity of EV research through business activities. In particular, we analyse the scientists' initiatives for commercialisation as a sort of 'household economy' to serve the sustainability of EV science. We conclude our article by discussing our findings in relation to value and valuation.

Background

We based the case presented in this paper on an EV research initiative in Finland in 2014–2018. The initiative brought together experts and institutions from various branches of biology and biomedicine, biobanks, public academic institutions, and private medical companies under a public innovation promotion framework called Strategic Centres for Science, Technology and Innovation (SHOKs). The Finnish innovation-funding agency, Tekes (Business Finland since 2019), administered the SHOKs, and the Finnish government participated in funding them. Above all, the SHOKs were policy instruments to boost flagship projects in innovative technologies and business domains through public–private partnership funding and collaboration. The idea was to encourage joint projects that were driven by the needs of industry and that allowed industry to renew and innovate with the help of precompetitive research done in collaboration with academic partners (Lähteenmäki-Smith et al. 2013).

To conduct their operations, a company was formed for each SHOK. One of them was SalWe, which focused on health and well-being. Founded in 2009, 33 partners (19 companies and 14 research organizations) were involved in SalWe. The EV research consortium worked under SalWe. In 2014, SalWe launched a 30-million euro biomedical programme on personalised medicine (Get It Done [GiD]), of which the EV consortium was part. Their research was identified as a rising field in molecular biology and biomedicine, and the EV research consortium was a possible way to make Finnish EV research more compact and coherent in terms of its organisation and technology.[2] Due to the SHOK framing, it was obvious that public institutions and private businesses were actively involved in the collaboration, because a SHOK imperative required companies to bring in about the half of the research funding. Consequently, the idea was that the research would serve the innovation interests of the company partners.

The EV study was conducted among a rather small group of partner organizations (n = 5), which exemplifies the character of SalWe and other SHOKs quite well: The work in them remained rather small scale, it was highly focused, and the projects operated for a limited time with a limited amount of partners within the restricted funding frame. SalWe and other SHOKs appear rather modest in their pursuits when compared to endeavours to build permanent infrastructures for biomedical R&D (e.g., the Finnish biobank co-operative or transnational BBMRI-ERIC) or to undertake grand initiatives to establish innovation, large-scale public–private partnership organizations (e.g., the SweTree company in Swedish forest technology or SINTEF in the Norwegian oil industry). SalWe and other SHOKs did not aim at projects at that scale; instead, they were public funding instruments that hoped to accelerate collaboration and joint initiatives by linking academic researchers and private high-tech companies. Nevertheless, the SHOK SalWe and the EV research consortium within it were endeavours among similar others in Finland. They were born from national efforts that have taken place all over the world during the past decades to promote public–private partnerships in knowledge societies, with the underlying idea that science would serve society better when organised around collaborations (e.g., Powell et al., 1996; Powell et al., 2005;

Etzkowitz, 1998, 2008; Gibbons et al., 1994). Life sciences and biomedicine have had especially pivotal roles in the following innovation pursuits and in the commercialisation efforts for research findings (e.g., Pavone and Goven, 2017; Mittra, 2016; Powell and Owen-Smith, 1998). Simultaneously, innovation policies in many countries have promoted these developments (Miettinen, 2002; Powell and Owen-Smith, 1998). This backdrop also applies to the SalWe and EV research consortium we studied.[3]

Our analysis concentrates on a variety of value and utility—actual, potential, and promissory—attached to the EVs in this consortium. Usually, studies on these kinds of partnership projects in life sciences or biomedicine emphasise the dominance of economic interests (e.g., Sunder Rajan, 2006; Fortun, 2008; Hauskeller and Beltrame, 2016b). Our approach is a bit different. We see the EV consortium as an example of biomedical research in which scientific goals and pursuits of clinical, social, and economic utility are simultaneously present and aligned, and we do not assume economic or commercial predominance beforehand. Our point of departure is the aim presented in the consortium's research plan:

> The major objective of the partners in the program is to create standardised technology platforms for extracellular vesicle studies. The novel tools and platforms can then be applied to the basic research and R&D of extracellular vesicles and the identification of EV-derived biomarkers. In the end of the project, there will be novel tools for monitoring the quality of blood products and novel sensitive biomarker methods for development of cancer diagnostics. In addition to research tools, the utmost objective of the partners is to create an active and intense national public–private network around the extracellular vesicles that will have link to international public–private researchers. (SalWe, 2013: 101)

Other formulations of the entanglement of scientific, medical, organisational, and commercial objectives were found in the research plan as well. For example, the consortium set its task "to build up an internationally competitive research network" and to "ensure high quality research and innovations in monitoring health and disease" (SalWe, 2013; 99). Due to such a multitasking effort, EVs were in many ways seen as interesting and important life science and biomedical items. For example, EVs have the potential to generate discoveries in the life sciences, new tools for biomedical R&D, and new biotech products for clinical use and for sale, and they are considered the locus for building a research infrastructure (Tarkkala and Helén, 2021).

Many studies (e.g., Cooper, 2008; Cambrosio et al., 2009a; Sunder Rajan, 2012; Ong, 2016; Hauskeller and Beltrame, 2016a, 2016b; Aarden, 2017; Sun, 2017; Beltrame and Hauskeller, 2018) have identified and addressed this amalgamation of scientific, clinical, and commercial interests in current life science and biomedical collaborations. They have also shown that the partners in such collaborations depend on each other in terms of technical devices, finances, and epistemic authority. Such *hybridisation* characterises the organisation of research as well as its objectives, the research practices (Hauskeller and Beltrame, 2016a, 2016b; Beltrame and Hauskeller, 2018), and the research objects (see Cambrosio et al., 2009a; Tarkkala and Helén, 2021). Hybridity not only refers to the interlacing of academic and commercial pursuits (e.g., Cooper, 2008; Sunder Rajan, 2012; Ong, 2016; Aarden, 2017; Sun, 2017; Hauskeller and Beltrame, 2016a) but also implies a blurring of the conventional distinction between basic and applied science and the borders between clinics and labs or research and care (Cambrosio et al., 2009b; Cambrosio et al., 2018; Tarkkala, 2019). In this paper, we approach this practice by analysing the multiplicity of value in collaborative life sciences R&D.[4]

Our premise is that an object, a method, or even an infrastructure is currently attached by multiple value or, rather, potential value, in the life sciences (e.g., Dussauge et al., 2015a; Datta Burton et al., 2021). For example, a gene variation associated with a disease susceptibility, a method to cultivate stem cells, or consolidation of a biobank network may facilitate efforts for scientific discovery and the production of new knowledge in medical sciences, and thus have *epistemic* value. This, in turn, may increase the prestige of a research team or institution, bring in more research funding and other resources, and thus add *academic* value to the enacted item. New biomedical knowledge is expected to have the potential for translation into more precise diagnostics or new treatments that would be of *utility to healthcare*, either clinical or preventive. Many *social* values may be attached to a life science item's healthcare value. For example, for patient or disease advocacy groups that pursue new knowledge and treatments of a specific disease or for organisations (e.g., biobanks) that facilitate such pursuits, a biomedical novelty may be valuable in regards to their hopes for a cure or to relieve suffering (e.g., Beltrame and Hauskeller, 2018; Mayrhofer, 2008; Novas, 2006; 2008). For governments and health administrators, such novelty and the R&D that goes into it have potential value in terms of public health and reduced healthcare expenditures (e.g., Datta Burton et al., 2021; Mittra, 2016). Obviously, a life science item—a molecule under R&D, a new method or technical device, or an infrastructure—may have several dimensions of *economic* value creation (Helén, 2016: 266-267). New knowledge can be further developed into a product or service that can be marketed in the healthcare business and bring profit to a company. Alternatively, a novelty can acquire a patent, and the patent owner may receive income in the form of a lease. Furthermore, an innovative R&D company focussing on a promising item or technology can be an investment target because it can yield profit for investors, either in dividends or—more frequently—in capital gains when selling company shares. In the following, we show that the multiplicity described above is also characteristic of the assumptions of EV value and value creation.[5]

Following Birch (2017a) and Muniesa (2017), we approach this multiplicity from the premise that any value of the EV as an object of life science is not intrinsic to it (Dussauge et al., 2015a), and it is not only the research-related labour that creates or adds its value. Instead, multiple forms of value and utility from the EVs and the R&D work on them are created, added, made, maintained, and modified by discourses and practices of valuation. The latter concept refers to an idea that the value of things is processual; it is engendered by situated practices and discourses that attribute certain kind and amount of value to a thing or action or that order things according to their value. Enacting things usually implies their valuation in many regimes of worth simultaneously, and thus, the value of something is determined in practice (Helgesson and Muniesa, 2013; Dussauge et al., 2015b; Kornberger, 2017). From this perspective, when EVs are enacted—in everyday research practice and contexts in which research is advocated, assessed, reflected, or otherwise performed—they are attributed with value.

Because a life science item's value, such as that of EVs, is an outcome of enactment (i.e., social and political practices), the value can be malleable; that is, a variety of forms of value can intermingle, and many desirable outcomes can be present simultaneously (Dussauge et al., 2015a; Datta Burton et al., 2021). Moreover, all value types in the context of biomedicine, or technoscience in general, tend to be inexact and 'unaccountable' (Birch, 2017a: 433–434) in two senses. First, value is hard to define by calculation or accounting, and second, there is no guarantee that value or acclaimed benefit exists—or will exist—at all. Such vagueness also applies to variations of economic value and value creation (see Birch, 2017a; Muniesa, 2017; Datta Burton et al., 2021). This feature is closely related to the fact that such forms of value are mostly imaginary or 'fictitious' because they refer to and are framed by future possibilities, probabilities, and visions (see Beckert, 2016), especially in economies of technological innovation (Beckert, 2016: 169–187; Mazzucato, 2018: 189–201), including the medical bioeconomy (Birch and Tyfield, 2013; Dussauge et al., 2015a; Mittra and Zoukas, 2020). This means the value of life science items lies mostly in their potential for scientific discovery and academic fame, clinical novelties, or economic gains. In other words, any value attributed to an item, such as EVs, is prospective and promissory, almost without exception.

In the domains of biomedicine and bioeconomy, expectations play a key role in valuation—in *parlance* and practices that create, maintain, and perform value, utility, and benefits (e.g., Brown, 2003; Fortun, 2008; Tarkkala et al., 2019; Mittra and Zoukas, 2020; Ong, 2016; Sunder Rajan, 2006). Unsurprisingly, expectations and prospects are also decisive in valuing EVs; a 'machine to make a future' (Jacob, 1982; Rheinberger, 1997; Rabinow and Dan-Cohen, 2005) was launched to build around these miniscule biological entities. Obviously, 'future' here refers to the scientific exploration of the 'unknown' in the life science laboratories (Rheinberger, 1997) and the expected or promised applications of the new knowledge (Brown, 2003). In addition, it signifies the efforts to build continuity for the research groups and their work (Miettinen, 1998; Tarkkala and Helén, 2021).

The STS literature on valuation and expectations' role in advanced technoscience discussed above provides us a perspective from which to approach the Finnish EV research consortium. We study valuation of EVs and EV research as discourses and practices used by people working within this particular biomedical R&D setting. Since the consortium was a hybrid in a manner discussed above, we pay specific attention to the multiplicity and malleability of value attached to EVs and EV research in this context. We also examine the ways various value dimensions interlace. In other words, we are interested in *the variation of value and valuations that appear in life science and biomedical R&D* and *the ways in which various dimensions of valuation are entangled with each other*. Furthermore, our analysis highlights that EV research is a new and evolving area of life sciences and biomedicine, and therefore the valuations tend to emphasise the prospective value and future utility of the EVs and EV research. Therefore, the manifold *value potential* of EVs is at stake in their valuation and value creation.

Our paper also focuses on the aspect of economic and commercial valuation in the context of the Finnish EV consortium. The reasons for this emphasis are obvious. First, the consortium was a public–private partnership project that brought together academic and commercial stakeholders and their respective interest and objectives. Second, studies on topics similar to ours often highlight the commercial aspects of life science or biomedicine (e.g., Pisano, 2006; Martin, 2015), and they provide plenty of evidence that vanguard biomedicine and life sciences are profoundly conditioned by and entangled with 'bioeconomy' (Cooper, 2008; Birch and Tyfield, 2013; Mittra, 2016; Sunder Rajan, 2006) or 'technoscientific capitalism' (Muniesa and Birch, 2020). In this paper, we approach the interlacing of science and economy, or science and business, in biomedicine and life sciences by analysing the role and weight of commercial reasoning and value expectations in our case (i.e., the Finnish EV consortium). In addition, we also analyse the mode that the pursuit of economic gain and commercialization took in the consortium. We take Muniesa's (2017) claim that economic reasoning and vernacular of value creation provide the dominant framing for the objectives of R&D and valuation in technoscience as our lead, and we juxtapose the findings of our case with his view (which is shared by others; e.g., Waldby and Mitchell, 2006; Sunder Rajan, 2012; Martin, 2015; Birch, 2017b) that economic or commercial valuation dominates the landscape of biomedicine and life sciences.

Data and methods

We based this article on data collected in the context of an R&D project on EVs in Finland that was part of SHOK SalWe's GiD programme on personalised medicine in 2014–2018 (see above). For this article, we used three types of data collected between 2015 and 2017. First, one of the authors conducted 11 interviews with 10 informants who were either research partners (n = 4), company partners (n = 4), or representatives of management with expertise in SalWe and SHOK programmes (n = 2). In the text, we refer to the informants by indicating only their roles because of the low number of participants. Second, we utilised field notes based on observations in two public conferences with EVs in the programme as well as field notes on seven project meetings, in which the EV research consortium and its findings, developments, and current state were discussed. Third, we utilised scientific articles on EVs to contextualise EVs in the biomedical research field.

We analysed our data by applying systematic content analysis, with the support of the case study approach and STS ethnography (see the Methodology section in Tarkkala and Helén, 2021). The latter approaches helped us to contextualise the interview and textual data and to triangulate the results and conclusions of our analysis. A comparison of interviews, field notes, and published research papers allowed us to situate our findings analytically. The goal was to keep our content analysis inductive, so that the thematic emphases and the patterns of reasoning in research materials would first become eminent to us. Yet, even when our priority was to start from the data, we conducted our analysis in dialogue with literature discussing the (bio)economies of the life sciences and biomedicine, especially regarding value creation and the character of public–private partnerships in these domains. Given this approach, we first organised the research interviews with the help of the Atlas.ti program. Then, we systematically read the interviews and other material, focusing on the participants' discussions about the importance, benefits, and utility of EVs and the research on EVs in the context of the consortium's work and objectives. With this reading, three recurrent valuation themes or, rather, configurations came to the fore: interlacing of a variety of value dimensions around the scientifically promising EVs, the prime value of collaboration enabled by the consortium, and the foremost significance the EV Core facility service as a major outcome of the consortium. In our second systematic reading of the data, we took a closer look at the participants' reasoning about these configurations, with special attention paid to their comments about value, the potential of the EVs, EV research, and the work of the consortium. With this reading, we were able to obtain a glimpse of the way a variety of value dimesions are entangled with each other in valuation of the EVs, juxtaposing the 'basic science' efforts and technical expertise of the consortium with prospects of medical utility and commercial value creation.

Valuing EVs

In this section, we analyse the EV valuation within the research practices of the Finnish EV consortium. In our previous study of the consortium (Tarkkala and Helén, 2021), we showed that in the public–private partnership milieu for life science R&D, the EVs are enacted as an object upon which continuity and sustainability of an emerging life science domain can be built. The same concern over ensuring continuation of scientific research is also prominent when it comes to valuation of the EVs. In our analysis, we focus on concrete items or activities such as collaboration, expertise based on specific craft in laboratory techniques and work, and availability and quality of tissue material and data that the consortium partners considered essential to EV research enduring in a competitive scientific and business environment. These same aspects form the bedrock for value potential of the EVs, which we present in the following sections.

Collaboration as an asset

Exploring EVs requires many types of scientific and technical expertise. The consortium partners reasoned that the most pronounced value, or utility, of the EVs was their power to gather experts together across institutional and disciplinary boundaries, which is congruent with the observations that transdisciplinarity is characteristic as mingling of science and business in most areas of new technologies (e.g., Svalastog, 2014). In both public academic labs and private companies, researchers emphasised that the expansion of opportunities for collaboration is this endeavour's most important asset and is the most likely to add value to their work:

> Well, it is a win–win. Synergy. Like, when people have different viewpoints, different angles and different needs (…) then we just get more done. There are more people with a joint interest in doing things and, on the other hand, knowledge and other resources. So, we are stronger than we would be as a single group, or what is worse, as competing groups that just fiddle around with their own thing and jealously look around at what others are doing. (Research partner)

> This is purely about networking. We are a company partner and yet it is very important for us that we have contacts with basic research, and this is a very good way to create a wider network we would otherwise not necessarily come into contact with. (Commercial partner)

A number of aspects should be noted in consortium partners' reasoning that collaboration is beneficial for both their efforts and the entire EV research field. First, they saw that the scope and volume of research activity and expertise on EVs extend because of the collaboration. The joint R&D programme made larger and more diverse pools of samples available, which all partners considered to help them to obtain more sophisticated and reliable results. Extension of sample availability was particularly important for commercial partners. Collaboration with academic groups provided them a steady supply of research material. Moreover, collaboration brought complementary scientific expertise and technical expertise to each participating academic and commercial group, which reinforced their work in their individual subspecialties and allowed them to work widely in the EV research domain. A commercial partner reasoned:

> As a small company, we can't do everything by ourselves, and (…) we are not particularly eager to establish a big scientific set-up of our own (….) Therefore, we try to get this collaboration to work as well as possible, so that the academic partners would do things that would also benefit us—and the whole consortium, of course. (Commercial partner)

Consortium partners not only talked about the extension and increase of their personal expertise but also emphasised that collaboration reinforced and widened the scientific and technical expertise of the entire Finnish EV field, which was beneficial because it increased Finland's significance in the international EV domain.

> All of us [Finnish EV researchers] started by developing studies and methods on our own. Now, when we know what we have in common and are all together, we have noticed that the situation is quite good, in fact, and we are quite competitive internationally in our research. During the ICEV meeting, we noticed how efficient we are together (…). As compared to what others do, we can look at and examine vesicles in so many ways, and due to that, our results are stronger. Others rely mostly on one or two techniques they happen to have in their own labs, yet some element is usually missing; but we have them all. (Research partner)

This is closely related to another aspect of utility in collaboration that the participants emphasised. Academic and commercial partners repeatedly said the joint programme added value to their work by opening up a wider range of opportunities for scientific, R&D, and commercial collaboration. Many interviewees highlighted alliances between unexpected parties that would not have otherwise formed. The consortium's core alliance intermingled two research laboratories from biomedicine and biosciences, which had separate technical specialties. In addition, the meeting of 'basic' science and companies with commercial pursuits was considered 'unique' and beneficial:

> SalWe makes possible joint research that was otherwise quite unlikely to take place in the academic world. Without Tekes funding or the like, we hardly were in collaboration with these [names removed] or other companies. The university is poor, and the companies are interested in scientific results, so there is always an overlap that will make both parties interested (.…) I suppose that this joint research [on EVs] enables development of some sort; yet, we are very much involved in basic research in this SalWe project, this is not yet very applied research or oriented to develop products. (Research partner)

The increase of collaborative relations and activities contributed to the integration and coordination of the Finnish EV research and development. This was seen as beneficial because the weight of their expertise started to increase internationally, which in turn opened the partners to more 'interfaces' for collaboration abroad. The management of the SHOK programme highlighted the same:

> I have realised the value of collaboration; it's just the same if you seek export collaboration. Anyway, it is better to do things together with another company or companies than alone. In all activities, collaboration is unbelievably valuable because together, you deliver so much more than by yourself. This is what I learned in SalWe. (Programme representative)

The participants also talked about collaboration utility in terms of economy. The academic and commercial partners predominantly framed the work done in the EV consortium as 'basic research' or 'basic science', with an emphasis on development work in terms of, for example, standardisation and technology (Tarkkala and Helén, 2021). Commercial partners were quite content with this orientation, and they readily acknowledged that they should not expect results that could be commercialised immediately. Rather, they reasoned that participation in the joint programme was a long-term investment. Thus, the consortium was, in practice, impregnated by an ethos of 'basic research' (Tarkkala and Helén, 2021). This could be said to define the baseline for all EV valuation because all of the participants acknowledged the need for technological and scientific stabilisation before any of the EVs' potential commercial utilities could be actualised. The research plan already underlines that there will be no "solid and reliable diagnostic and clinical applications" without first developing "the basis of the EV technology and characteristics" (SalWe, 2013: 99).

In this context, commercial partners quite often reasoned that, for their R&D with commercial objectives, a significant form of value from hybrid collaboration was nevertheless *scientific*. The 'basic' science of academic partners could provide firm facts and valid methods and techniques, as a solid backbone and guidance for their own more practical work to develop marketable products and applications (see also Lee, 2015). A discussion between two commercial partners exemplifies this:

> Partner A: By approaching this from a basic research perspective, we cannot go wrong. … In any case, we have displayed unequivocally that the vesicles are there—for instance, in the preparations—and they increase. They have significance.
> Partner B: This is not just in our heads!
> Partner A: But whether it makes any difference and whether it brings any utility in an applied or medical sense—that, we do not know. But one of our goals is to find out what happens there—basic research.

One of the collaboration benefits for academic partners was related to research financing. The alliances with other academic groups and commercial partners resulted in further joint funding applications. Notably, the EV consortium's academic partners saw benefits from the funding provided by the GiD programme. The funding invested by the company partners allowed the academics to conduct investigations and experiments focussing on the EVs' basic biology and on developing basic research techniques and methods. Many of our interviewees lamented that this sort of work was unlikely to attract 'more scientific' public research funding (see Tarkkala and Helén. 2021). This tendency was especially underlined by researchers for the 'storage study' work package, which focused on the EVs' quality and functionality, such as in red blood cells and platelets from urine during and after storage. The task was rather practical: to search for "advanced indicators of the functionality of blood products and their condition" (SalWe, 2013: 100). Yet, the participants were unanimous in saying that, in practice, their work in the storage study was about "trying to find out and clarify what really happens in the bag [of blood product] from the perspective of the vesicle; quite basically, that's what this has been all about" (Commercial partner). They also shared a view that life science research proposals must show novelty. A researcher noted that their research plan, which continued this line of research, was rejected because of the seeming lack of novelty, even though there was still much to study, so the lack of novelty "was a true misconception" (Research partner).

The collaboration with a commercial partner provided the academic partners with necessary resources for the storage study. In particular, partnership funding within the GiD programme allowed them more time to perform follow-up analyses and to keep more people involved in the project than usually possible (Tarkkala and Helén, 2021).

The above reasoning that hybrid collaboration brought vital benefits regarding what the research funding would allow was closely related to the value of collaboration in reinforcing the institutional and financial sustainability of EV research and its technical infrastructure in Finland. The academic and commercial partners shared the value of continuity and concern over future possibilities to proceed with ongoing (and unfinished) work. This became particularly evident in the context of the work package focusing on antibody and biomarker research (see below). In 2016, the researchers told us that government funding for the GiD programme was reduced and that its duration was cut by a year. Due to this, the

EV consortium and this particular study needed to focus more narrowly, and some research lines had to be dropped (Tarkkala and Helén, 2021). In such a setback situation, the researchers involved hoped that the academic partners could somehow carry on with the topics they considered scientifically interesting, while the researchers simultaneously admitted that, outside of the GiD work package, there might not be any funds with which to continue. The academic partners saw that the programme cuts may lead to a situation in which no funds for salaries would be available. This would affect the EV research considerably because the specific craft expertise (on the importance of craftsmanship in the life sciences, see Meskus, 2018) could disappear as people move to other organisations and labs. In addition, the situation was dire for the commercial partners, making their prospects of continuing the work on EVs uncertain. They were dependent on their academic partners, as, for example, the supply of EV material was difficult to obtain without a collaborative tie to the university group. The vital value of collaboration as facilitating continuity in research, expertise, and technical infrastructure was especially highlighted when our interviewees discussed the EV Core facility's establishment at the University of Helsinki as the consortium's most remarkable achievement. We discuss the EV Core in detail later.

Multiple intermingled values

When consortium participants talked about the value or utility of EVs and EV research for biomedicine, they repeatedly attached multiple dimensions of value to their research object. This is unsurprising because the intermingling of scientific, clinical, social, and ethical valuations with the potential for commercial profit or other economic gain seems to be a common feature of hybrid partnership projects in current life sciences (e.g., Beltrame and Hauskeller, 2018; Brown, 2003; Datta Burton et al., 2021; Prainsack, 2017: 107-135; Sharon, 2018). The commercial goals attached to scientific research tend to direct it to more applied and utility-oriented objectives (e.g., Etzkowitz, 2004; 2008; Glenna et al., 2011). This tendency was apparent in the EV consortium's research proposal (SalWe 2013), but as we have shown (Tarkkala and Helén., 2021), our interviewees framed the project as essentially and predominantly 'basic research':

> At the same time as we produce utility or try to search for something the companies could utilise, we have to set up certain things so that we understand, methodologically, what we have. We cannot just take something and say that this is how it is; we have to know it exactly. And as these methods are very much in their early stages, at the same time, we have been interested in EVs in general, what they are and what they do, and why. All this knowledge has been valuable to us. (Research partner)

The above quotation addresses multiple aspects of EVs' value and utility simultaneously and intertwined. Almost without exception, the EV researchers saw their work with EVs being of great utility for molecular and cell biology and biomedical science. Then, this scientific value is immediately attached to EVs' possible clinical utility and commercial potential. Their reasoning was not parallel valuation; scientific, clinical, commercial, and social value existed side by side and were represented by partners with different interests. Rather, valuation appeared as a hybrid performative act, in which scientific, clinical, and commercial dimensions of value and utility were simultaneously addressed and inseparable, regardless of a partner's interests and objectives.

Such a hybrid valuation was particularly clear in the work packages related to identifying the biomarkers of prostate cancer and to developing an antibody as a candidate product for a commercial partner. The EVs' expected scientific, clinical, and commercial utility was sought simultaneously in joint research efforts, but the same potential results concerning antibodies and what they identify were valuable for the different partners in different ways. For example, cancer researchers hoped to discover if EVs could be a source of biomarkers for prostate cancer; they also were interested in discovering whether urine was a better source of biomarkers for early stages of cancer and whether plasma was a better source for later stages, as well as whether EVs can help to differentiate slow-growing from aggressively growing cancers (SalWe, 2013: 101). In the eyes of a commercial partner, success in this line of research would open up a variety of diagnostic possibilities:

> There's plenty of hope that there exists something new [in EVs] that would help, for example in the diagnostics of certain diseases—that we'd find a biomarker like prostate-specific antigen (psa), for instance. Vesicles are hoped to be a quite wide source of biomarkers, not only for prostate cancer. Would it become possible for us to see that a group of patients have this sort of EVs, and this sort of content in EVs, and then think about if we could start to treat this group and how? And then, after the treatment, would we see that the [bio]marker has vanished and the cancer has been cured? (Commercial partner)

Finding specific markers for specific cancer types or specific diseases was not the only interest of the commercial partner that developed and sold antibodies. For the company, a well-known and functioning antibody could allow further development of a potential new product, regardless of whether it was specifically related to prostate cancer or not (Fieldnotes, 2016). For the academic partners, precise identification of an antibody and what it recognises could be a good result that would help to advance EV analysis techniques. An antibody, once standardised, could become part of scientific exploration in a technical sense—that is, as part of the basic research equipment (Tarkkala and Helén, 2021).

Despite these differences, researchers from different branches considered the research effort holistically and saw the different dimensions of potential value as entwined.

> There are two views ahead: if we could find an antibody that would function as a proper marker to discriminate vesicle populations from each other, or identify them, or something, then we could hopefully develop it further in the future. Moreover, if a product with diagnostic or clinical significance could be developed from such an antibody, well, and a company [name removed] could benefit with a good [commercial item], for example, that would be awesome. (Research partner)

> The study on biomarkers of prostate cancer is proceeding well, it looks promising, and the antibody study is also well in progress; hopefully, it will deliver something and also some business (…). We have used the samples from the Helsinki Urological Biobank [in the antibody study]. They are prostate (cancer) antibodies. Hopefully, and then—if they really are prostate cancer antibodies, or even vesicle antibodies—we could use them in some kind of technology application (…). If they were specific to prostate cancer, they could be used in diagnosis, or they would allow for detecting the pathological condition better. Or, if they were just general vesicle antibodies, they could be used in some assay kit, as part of a purification method. So, it remains to be seen what they really are; investigation is ongoing (…). For sure, this will be a good result, and I reckon that these antibodies will be good for [a company; name removed] also, because it may develop business based upon them and sell them. This is how it should be, and this is the purpose of SalWe, in fact. (Research partner)

As we see, for the partners of the Finnish EV consortium, the value of the EVs—in any sense—is not exact nor calculable, and their utility is not precisely focused. The EV valuation comes with expectations and promises. Their potential for biomedical discoveries, clinical use, or making profitable medical products is what is valuable. Within biomedical R&D, the EVs' prospective value takes on various modalities. The EVs are considered an 'epistemic thing' (Rheinberger, 1997) with the potential for scientific novelty (Tarkkala and Helén, 2021). As potential biomarkers, they carry promises of clinical and commercial utilisation; as a stimulus for developing research techniques and methods, they facilitate sustainability of Finland's entire EV domain. That the EVs are seen as valuable predominantly through their potential and expectations reflects an overall orientation in biomedical R&D towards choreographed future making (see Rheinberger, 1997; Rabinow and Dan-Cohen, 2005). Therefore, all sorts of forms of value attributed to the EVs are indefinite and imaginary. Yet, this same vagueness allows for the hybrid valuation of biomedical objects and their research (i.e., addressing the EVs' expected scientific, clinical, social, and commercial utility as simultaneous and intertwined). The Finnish consortium partners acknowledged their work as, more or less, just taking first steps in the new domain, which is why they largely emphasised scientific value and utility as primary.

Despite the emphasis on 'basic research', there was also rhetoric on future uses and benefits, which brought diagnostic and clinical utilisation into the research focus. Scientific work was believed to meet simultaneous expectations of 'translation', even when the EV research was in an early phase. A researcher working in the storage study commented,

> When thinking about applying for funding and so on, the applications must be very future-oriented, and so when the grant applications are written, the potential usability of the results [in the future] must be very thoroughly thought through. One always tries to consider the potential usability of the results, but especially when it comes to the specificity of this field, in which even the very basics are still part of the search, the preservation of samples is extremely important to know and explore. (Research partner)

All of the academic partners also agreed that the commercial partners' involvement influenced how the project was targeted and the work was carried out. The project's hybridisation reached the research object and everyday practices (Tarkkala and Helén, 2021), as well as valuation, which induced continuous efforts to balance the requirements of "industry-orientation" with that of producing "basic understanding and knowledge" (Miettinen, 1998: 436). Despite the strong ethos of and commitment to R&D collaboration, the balancing efforts implied potential frictions between the partners' interests and valuations. They also implied questions about how different types of potential value would be actualised, which parties will benefit from the collaborative work, and by how much. For the commercial partners, it was obvious that the joint effort should result in something that would produce revenue and profit only for them, at least in theory. Therefore, they needed to weigh the benefits of 'selfish' pursuits to extract EVs' value potential through patenting or commodification against sharing their results and technology with other consortium partners to add value potential. A commercial partner reasoned over the dilemma:

> This is related to the demarcation: what we bring to this project, what we keep to ourselves, and what is protected by our own patents. (…) But [my company] also must spot a sort of parallel supportive area that can be shared in the joint effort, which will help me to develop the business. (…) Of course, the companies realised they are involved in discovery activities in the joint consortium, and therefore, publishing [the findings] is business. If you have a scientific publication to back up your business efforts, that is the most convincing kind of business. If we consider developing our healthcare system, innovations in healthcare, or treatment of diseases, we need science as the groundwork to show that the novelties really are something. When we, a few years ago, worked on long-reaching developments in emerging research areas in [previous company], we faced the same question: should we just keep quiet and just patent quickly, or should we tell the world about the new findings as quickly as possible? It is the latter that one should do: one should make the boost stronger, so that the world will start to look at Finland. (Commercial partner)

The EV field's future orientation and relative immaturity helped to prevent potential tensions from escalating. Because the route to commercialisation was not evidently quick and straightforward, it would have been premature to agree on the matters related to that step. Moreover, the SHOK framework had its own set of rules for commercialising and patenting, meaning that each stakeholder would be provided a possibility to benefit from the potential findings. Thus, these sorts of issues could be suspended during the actual working period. In parallel, the focus on the technicality considerably helped to maintain unity and the solid conduct of the consortium's work, despite their multiple interests and valuations. The work aligned scientific pursuits, efforts to develop items or methods with clinical or commercial use, and activities to organise a facility for providing biomedical research services. They emphasised that the work on EVs was primarily about technology and methods. Consequently, value expectations and prospect actualisation were subordinate to the technical dimension—or technical valuation—of EV research. Technicality provided a common ground for all of the consortium partners' diverse pursuits and valuations. As a dialogue between commercial partners summarised,

A: The configuration has been good in this [work] package because we all have clear interests of our own, but we do not have worry about this situation at all. We can share the whole technology topic and many things.
B: And the results we will achieve.
A: Yes, because we know that we all have our own domains, but there is also an intersection zone.

Core as a service—a business model

For many, the collaboration's most notable result was the EV Core facility's founding. The Core, operating at the University of Helsinki since 2016, is presented on its webpage as an analytical technology platform (see Figure 2), providing "infrastructure, state-of-the-art and emerging EV-technologies for research groups, hospitals, companies and authorities in the EV-field". In addition, the Core offers "diverse EV isolation, purification and characterization services and (…) contacts to various downstream analyses in other core facilities based on optimized EV-protocols" (https://www.helsinki.fi/en/researchgroups/extracellular-vesicles/ev-core, 12 Dec 2020).

Undoubtedly, the current life sciences are technosciences. Yet, the craft of experimental laboratory work—specific tacit capabilities for handling tissue samples, other biomaterials, new devices, and techniques and for managing unexpected occurrences at the bench—is still elementary for conducting experimental science and achieving novel results (Meskus, 2018). When the EV Core was planned and founded, this life science craftsmanship became highlighted. At the centre of the EV Core's formation was special equipment, such as Apogee A50 flow cytometry and an electron microscope, as well as the expertise to use these devices.

Many consortium participants thought that their joint efforts gave Finnish researchers a precious asset because the efforts enabled them to develop advanced craft expertise in EV analysis. The Core's key persons saw that this craft expertise could be commercialised as a 'service' to academic and private 'customers' for a reasonable price. Such reasoning emphasised the EVs' commercial value in an entirely new way. The commercial aspect no longer means that academic partners collaborate with private companies or that companies are expected to develop marketable products. Now, 'basic' EV research and, especially, technical expertise on methods and equipment of EV analysis—their specific craft—were seen to have commercial value potential as a service. A key academic partner at the Core expressed this new view by saying that the facility service's founding meant that "one could do small business and,

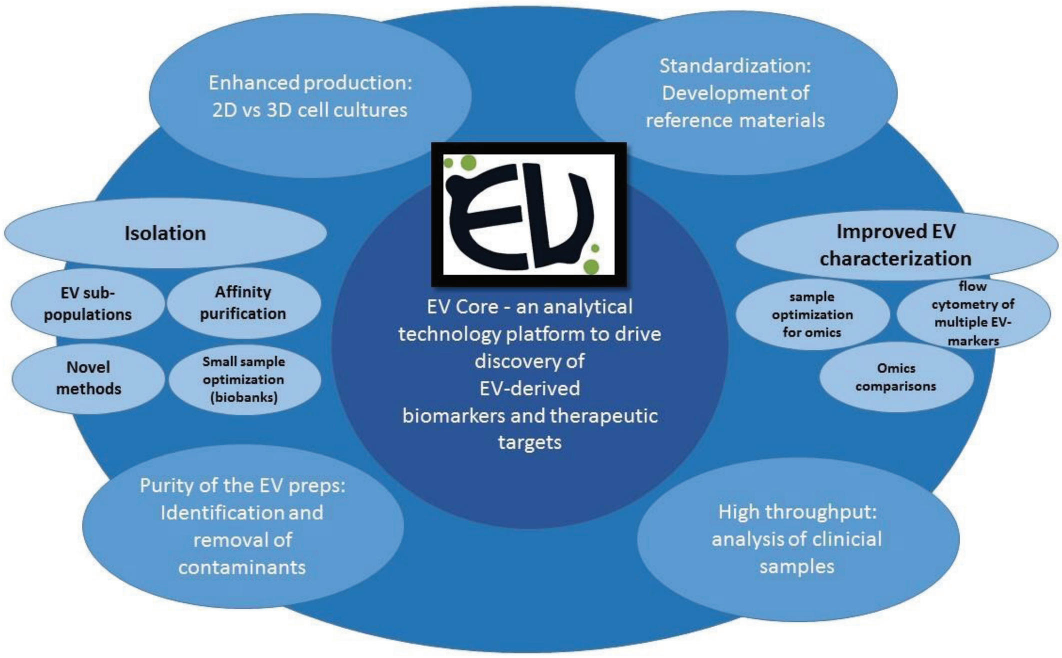

Figure 2. Core facility, as presented on their homepage in 2018 (7 September) (https://www.helsinki.fi/en/researchgroups/extracellular-637 vesicles/ev-core)

perhaps, guarantee oneself a more stable income", instead of trying to collaborate with everyone. Notably, the planned commercial collaboration at the EV Core was not comparable to the collaborations related to biomedical infrastructures like biobanks (Tupasela et al., 2015; Helén and Lehtimäki, 2020) or with biobank research consortia like the Finnish FinnGen (Tupasela, 2021: 113-124). The Core was seen primarily as a continuation of the work done in the EV consortium and other projects, and the scales of the business and its profitability were very modest.

The business aspect and commercial prospects were highlighted at the time of the EV Core's launch, when it was presented as a potential "export platform" at Tekes's innovation meeting and was pitched at the major technology start-up event SLUSH. In this context, EV research was redefined in entrepreneurial terms as innovation in business and commercialisation. It was also influenced by familiar models and 'choreographies' (see Mason et al., 2019) of the innovation economy involving direct transformation of academic discoveries into a marketable product or a start-up company. This line of action and the increased weight of commercial value expectations became more eminent with the R&D project FastEV, which the key persons of the EV Core initiated later. The FastEV was promoted as "a novel, simple, fast, scalable and cost-effective method for EV isolation [that] produces a pure EV preparation with versatile applicability in both biomarker studies and therapy" (SPARK pitch, 2018). With Business Finland's funding, the project was aimed at improving "the commercial maturity of FastEV by identifying the most promising customer segments, applications and commercialization strategies" (SPARK pitch, 2018) and sought "collaborators and partners (…) for proof-of-concept testing of the FastEV isolation and downstream analysis" (Biospace, 2019). In 2018–2019, FastEV was actively pitched at large start-up events in Finland and the rest of Europe. In these forums, the Finnish team promised to "offer our early stage partners a great position to benefit from a ground-breaking technology. For them, FastEV provides means to get ahead in the EV race" (Biospace, 2019).

With the founding of the EV Core, the value potential of EVs and EV research gained more prominence in biomedical business. However, this shift did not mean that commercial valuation would have subsumed other value aspects of the EVs. The 'business model' of the Core facility was based on an idea that Core did not have to make profit per se (Palviainen et al., 2017: 78), as long as it could "sustain itself" (Research partner). Thus, service provision as a business was explicitly seen as instrumental because possible revenues and profits were sought only to maintain the biomedical research infrastructure, which would allow advances to be pursued in basic and clinical EV research. Similar reasoning can be found from numerous academic and public life science infrastructure projects seeking 'commercialisation', with biobanks being the clearest example (Beltrame and Hauskeller, 2016a; 2016b; Timmons and Vezyridis, 2017; Lehtimäki et al., 2019).

Thus, EV researchers considered commercialising EV-related techniques and craft expertise via the EV Core as instrumental. This reflects the fact that the consortium partners' valuation focus was on the continuity of EV science and R&D For them, the most important value and utility of the EV Core were the prospect that it would provide a more stable ground for sustaining and developing EV research in Finland, as well as continued awareness of the latest developments (see Tarkkala and Helén, 2021). The founding of the Core service can be seen as a parallel action of doing research and ensuring the continuation of research (see Miettinen, 1998). Doing 'small business' by providing services involving expertise and specialised craft is considered an activity that should serve the continual pursuit of basic science. Therefore, it is merely one dimension of a general effort to make EV research more sustainable in Finland.

Although models and ideas of start-up and academic entrepreneurship became more eminent in the Finnish EV research domain with the EV Core's founding, people involved in the Core and EV research saw such commercialisation as an element of the 'household economy' of academic biomedical research. By 'household economy', we refer to a situation familiar to most academic research groups and laboratories in the life sciences, in which they constantly apply for and try to acquire funding (often short-term) from multiple sources to cover the expenses of equipment, facilities, and personnel costs, while permanently rearranging their activities and budgeting to ensure research continuity. In interviews, academic research partners repeatedly commented about the precarious condition of the vanguard life science, in which concern over continued funding and a sort of involuntary parsimony were permanent features of the work. One research partner described how an academic group responded to this economic challenge:

> We sail at sea with our tiny EV vessel (…) Well, I had the SalWe money and a grant from the Academy [of Finland], and neither of them would have been enough alone, but together, this funding has supported my work so that, in terms of scientific research, this has been the most rewarding period of my life. (…) I've had an opportunity to become involved in plenty of activities, and it has been utterly awesome; for this reason, it would be heart breaking if all this collapsed. I am very satisfied. The Core wouldn't have come true if I hadn't hired an extra postdoc to build it. (…) I've been gambling, putting all my chips in the middle of the table, and I don't regret it. It is our team; it has been so marvellous, all these people; and now that they have learned to work together, these three postdocs (…) they are extremely talented persons to continue this work, and we have reached the phase in which the work is beginning to be productive, as when there are a lot of papers in the pipeline, some of them related to R&D. We have launched new research and found collaborative settings (…) [For the sake of all this,] we've been franticly seeking funding, and therefore, I haven't been able to conduct research because half of my working hours are dedicated to teaching, and the rest of my time is dedicated to applying for money. (Research partner)

Such efforts engendered the mentioned household economy as a distinct framing for commercialisation. Within it, the EV Core's economic value did not lay primarily in the revenues and profit that businesses providing technical services may produce. Rather, it lay in expectations that the Core would provide more solid and visible bases for EV research and, especially, for the technical expertise it requires. Thus, the EV Core's most important value was related to ensuring sustainable EV research (Tarkkala and Helén, 2021), which would result in collaboration that is more intense at home and abroad and help the Finnish EV researcher groups to acquire funding in the highly competitive environment of global life sciences and biomedicine. This was also acknowledged on the commercial side of the Finnish EV domain, which was reflected in a commercial partner's evaluation that the EV Core brings international visibility and national stability to the field.

In a way, then, despite the multiple dimensions of valuations intermingling, the prime value in the EV Core's founding was in keeping up and staying in the game.

Conclusions

In this paper, we present a case study on multiple forms of value and value creation in a Finnish interdisciplinary research consortium studying extracellular vesicles (EVs). The consortium was part of a research programme on personalised medicine (GiD) funded by the main Finnish public innovation funding agency in 2014–2018. Within the GiD programme, funding was directed to collaborative projects between public research institutions and private companies, with the goal of combining scientific research with commercial R&D. In our study, the Finnish EV consortium is an example of a hybrid life science in which a scientific endeavour and pursuits of clinical, social, and economic utility are aligned and simultaneously present (Tarkkala and Helén, 2021). As Francis Lee (2015: 222) said, "The tropes of medical development, economic innovation, and scientific progress are all present in the biosciences, and scientists perform and relate to all of them at different junctures".

The participants saw EV research as being in an early stage, as both a domain of science and a biomedical market. In this context, the EVs were attributed with forms of value associated with expectations in terms of potentiality and continuity. Our analysis shows that valuation in hybrid life science is characterised by the dynamics of value expectations, in which the scientific value opens pathways to other kinds of values: clinical, commercial, social, and so forth. However, the scientific value was not considered absolute or independent from other kinds of values; instead, the potential scientific value of EVs for biomedical science appeared entangled, or hybridised, with other types of value in the consortium partners' speech and reasoning. This resonates with a conventional understanding of basic science as an initiator of all things new.

The SHOK SalWe and its GiD programme provided the Finnish EV consortium's funding and institutional framework, making it a public–private arrangement quite typical in life sciences today. Many studies claim that economic and commercial interests and value predominate such R&D configurations and determine the ultimate research objectives. Among others, Muniesa (2017) presents a general claim that economic valuation dominates today's technoscience. According to him, the reasoning of 'value creation' concerning technoscience consists of multiple interlaced value dimensions, yet economic vernacular and reason form the most significant frame of valuation, which subsumes scientific, social, clinical, and ethical value.

Our findings are at odds with Muniesa's view, to some extent, and our analysis suggests a more complicated view of value hierarchies and of commercial valuation being entangled with other value dimensions in the emerging domain of EV research.[6] Obviously, the commercial value potential of EVs and EV research is continuously present in the Finnish consortium's discourses and mundane work; nevertheless, economic types of value form just a dimension of expected value creation and are interlaced with other valuation dimensions. Furthermore, the consortium partners shared a 'basic science' approach (Tarkkala and Helén, 2021), which implies a sort of temporal order of value expectations: pursuing science and developing specific technologies were widely considered primary because they were seen as indispensable for reaching clinical applications, marketable products or services, or other economic gains. Such dynamics of valuation reflect the Finnish EV research domain being situated in a specific niche within the global biomedical economy (see below).

What, then, is the weight of economic valuation, and what are the role and mode of 'commercialization' in our case? The influence of a technoeconomic rationale (Muniesa, 2017; see also Birch, 2017a) and the prominence of commercial valuation in the Finnish EV consortium were most eminent in the EV Core facility services at the University of Helsinki and its spin-off projects. The EV Core's business model exemplifies a specific formation of an academic bioeconomy, namely a kind of household economy in which business involving EVs in the biomedical R&D market is conducted to ensure the sustenance of scientific research. The idea that EV research is a biomedical science and that R&D primarily serves the 'common good' and will create value and utility for people and society is closely attached to such an instrumental view of business. This business model is not unusual in commercialisation rationales among academic research organisations and infrastructures, such as biobanks (Turner et al., 2013; Timmons and Vezyridis, 2017; Beltrame and Hauskeller, 2018; Lehtimäki et al., 2019). In this model, value creation—or, rather, value potential—is associated with two things. First, it refers to making money through a service business based on specific expertise to guarantee the continuity of a research unit and its research. Second, it means keeping up with the new domain's development, being aware of new knowledge and technology, and sensing 'weak signals' from the science and market domains. This reasoning highlights the value of craft expertise specifically in life science (see Meskus, 2018)—EV research, in our case—for doing business and staying on pace with the field's vanguard endeavours.

The household economy of Finnish EV research is interlaced with multiple biomedical economies and, obviously, is not detached from the global biomedical business domains, which are dominated by the technoscientific assumptions related to capital investments and market analyses (e.g., Hopkins et al., 2013; Mirowski, 2012; Pisano, 2006; Styhre, 2015), assetisation and rent extraction via the patents and IPRs (Birch, 2017b; 2020; Birch and Muniesa, 2020)', and innovation policy and its ideas of ecosystem economy (e.g., Mittra, 2016; Ong 2016; Aarden, 2017; Tarkkala et al., 2019). This academic household economy is a bioeconomy niche, perhaps situated in an embryonic phase of the value-creation chain or in a 'pre-competition' zone. Within it, the expert scientists and their allies conduct 'small business' with EVs and their own craft expertise, and they attach forms of economic value—or value prospects—to EVs and align them in a particular way, considering economic pursuits as instrumental so that seeking revenue or profit from their EV expertise business is a means to sustain their scientific work and academic careers. The emergence and existence of such niches and such business reasoning indicate the condition in which scientists and researchers are conducting basic R&D in the world of science, ruled by expectations of economic gain. Thus, turning the specific scientific expertise and craft into a small business, often called 'commercialization', becomes a reasonable strategy with which to secure the continuity and quality of their own scientific work and its prerequisites.

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Notes

1 A search by the term 'extracellular vesicles' in the PubMed database returned 2054 publications published in 2016. In 2020, the term 'extracellular vesicles' had 4296 hits (see https://pubmed.ncbi.nlm.nih.gov/).

2 We presented this research programme more comprehensively in Tarkkala and Helén 2021.

3 The SHOK did not stand on a particularly firm ground in the Finnish innovation policy. Since 2013, SHOKs were under political fire because they were seen as serving the interests of large companies too closely, not being crosscutting enough, and having too complex IPR model, to name a few examples of criticisms they received (Lähteenmäki-Smith et al., 2013: 27-28). For SalWe, GiD remained the last program, and it was finished some 6 months before it was due to end because the government gave up on the SHOK model and closed the companies by the end of 2018. In addition, the EV consortium had to make considerable adjustments to its work plans due to the premature ending of the project (Tarkkala and Helén, 2021).

4 For a more detailed discussion on the hybrid character of the Finnish EV consortium, see Tarkkala and Helén 2021.

5 STS studies focused on technology domains that are very different from ours highlight the simultaneous presence and intermingling of multiple value dimensions. For example, studies on waste management and recycling services (Gregson et al., 2013; Corvellec and Hultman, 2014; Olofsson, 2020) have an approach to value creation that is similar to ours. Those studies underline the importance of performativity and potentiality in valuation of waste and waste management technology, the emphasis of which is congruent with our approach to rather different items, namely EVs.

6 Our analysis and argument are not intended to deny the findings and insight of the studies on economic and commercial rationales in different technoscience domains (e.g. Birch, 2017a; 2020; Birch and Muniesa, 2020; Pavone and Goven, 2017) or studies on biocapitalism as the main frame of current life sciences and biomedicine (e.g. Cooper, 2006; Cooper and Waldby, 2014; Sunder Rajan, 2006). However, our study on EV research in Finland, as a hybrid mode of life science (see also Tarkkala and Helén, 2021), did not take the dominance of economic or commercial objectives in research practices as a default assumption, and we did not consider the reasoning of the people involved as some sort of ideological coverage or justification for their business engagement or pursuit of economic gains (cf. e.g., Johnston, 2008). Instead, our approach was first to take what EV researchers and others involved said or wrote about EVs, their work, and its worth at face value and then to analyse their discourse and reasoning in the proper context. By doing so, we were able to glimpse the manifold dimensions of valuation and multiple economies in which research in life sciences and biomedicine are embedded today. In our mind, this picture complements, rather than contradicts, the findings and arguments of the abovementioned studies.