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Julia De Gregorio

Trading animal genetics

On the "marketization" of bovine genetics in the dairy industry

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Abstract
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This thesis studies the workings of markets in the specific context of the international trade in bovine genetics in the dairy industry and with a particular focus on the Global North. It draws upon the examples of trade in breeding stock – cows – at auction sales and trade in bovine semen.

Inspired by the work of economic sociologist and actor network theorist Michel Callon on "marketization", the thesis uses a performative approach to the market economy. Hence it does not address animals and their live body parts as simply *being* commodities. Rather it looks at processes that "make" them become commodities. Engaging with the question of how animals and their live body parts are turned into commodities, it is primarily concerned with valuation and bio-securitization processes and with the role of the animals themselves in the commodification process. Examining mechanisms that allow for the workings of markets in spite of not only pre-existing obstacles but of differences, resistances and instabilities – potential limitations – arising in the process of trading itself, the thesis focuses on the iterative character of markets.

Based on findings derived from three empirical case studies, it shows how various forms of distinction are created in the marketization process of dairy genetics, and it demonstrates how these distinctions allow for trade. But the thesis also reveals mechanisms of distraction, suggesting that if markets operate on the basis of various forms of distinction, they do so simultaneously via mechanisms that distract us from the very distinctions created. It highlights the role of the human-animal divide in such processes.

The thesis is based upon ethnographic and interview-based fieldwork mainly conducted in Germany and in New Zealand. Triangulating between work on "marketization", the political economies of nature and nonhuman "lively commodities" in economic geography, and also on biosecurity, it seeks to make a contribution to these geographical literatures.

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List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I De Gregorio, J. Stabilized instabilities: on the unruly nature of a "lively commodity". Manuscript.

II De Gregorio, J. Trade-a-bull: the struggle over commensurability, and the satire of economic reason. Manuscript.

III De Gregorio, J. Securing value flows: biosecurity and the global circuits of a "lively commodity". Manuscript.

Contents

1. Introduction

> In value class I there are three 'young cows'; two Payssl, one Hulay. *Moo*. The first two, *moo*, with catalogue number 400, a Payssl daughter, gives 31.2 kg milk per day, offspring of Prohugo, a very appealing performance from the dam's side*, moo,* too, with a first lactation of 8800kg. And when you look at the cow, a very elegant, well-framed, milk-emphasized cow, with excellent feet and legs, and the udder, very glandular and tight fit, *moo,* with very correct teats. And also regarding her conformation, an absolutely excellent 'young cow' that we have here in first place (fieldnotes, 28 January 2016).

With these words the director of the federal state's institution for cattle breeding, responsible for this particular district in Germany, introduced the auction sale of cows at one of my first visits at the cattle auction. At these sales – these are auction sales of breeding stock – the 'best' cows are always presented individually by the breeding director before the actual auction sale starts. On that day the cows with catalogue numbers 400, 252 and 428 were ranked first, second and third in value class I by the evaluation committee in the morning of the auction day and are presented to the audience. They are guided around in circles in the auction ring, mainly by their owners who run dairy farms close-by. All cows are classified. The sales are organised along value classes. Cows, bulls and calves are auctioned. But the majority of animals on sale are cows. During the introductory speech, the breeding director highlights the qualities of the cows on sale, for example, the amount of milk they give per day and their mothers' – the dams' – performance in milk. He also mentions their fathers – the sires of these cows. "Payssl" and "Hulay", the sires of the cows with the catalogue numbers 400, 252 and 428, are AI bulls. Today, most dairy farmers do not keep bulls on their farm. They artificially inseminate (AI) their cows in order to get them pregnant and make them produce milk. And the animals themselves? The cows at the auction space do not always walk calmly next to their owners. They moo, poo, stand still, jump, move their ears and sometimes they run out of the auction ring dragging their owners behind them. The bulls whose semen is used to AI cows are largely kept at bull semen collection facilities. These facilities exist worldwide. The bulls' semen is also traded globally. It is collected, processed and stored in tanks filled with liquid nitrogen – liquid nitrogen enables the bovine semen collected from the bulls to be kept alive for a long time and to be traded, also across large distances.

This thesis addresses the trade in animal genetics in the particular context of the dairy industry. It examines the commodification process of animals and their live body parts drawing upon the example of the trade in breeding stock – cows – at auction sales and of the trade in bovine semen. Hence, it does not approach animals (and their body parts) as simply being commodities. The animals addressed in this study are farmed animals. Cattle have been traded for a long time. They were considered a form of mobile wealth early on in their domestication (Colombino & Giaccaria, 2016; Velten, 2007). But they still live a life. They are not commodities per se.

In this thesis cows and bulls and the bovine semen collected from them are approached as nonhuman "lively commodities". Following Rosemary Collard and Jessica Dempsey (2013), lively commodities are those whose capitalist value is derived from them being alive and/or promising future life. Importantly, lively commodities have a life of their own (Collard, 2014).

The thesis examines the commodification process of the particular lively commodities addressed in this study drawing upon the work of economic sociologist and actor network theorist Michel Callon on "marketization" (1998a, 1998b, 2007a, 2000b; Callon, Méadel, & Rabeharisoa, 2002; Çalişkan & Callon, 2009, 2010). Hence, it approaches markets not as pre-existing but as always needing to be made – "stabilized" – in order to exist. It looks at processes that stabilize animals (and their body parts) as commodities, rather than approaching them as commodities per se.

Addressing the question of how animals and their live body parts are turned into commodities in the context of markets in dairy genetics, the thesis is primarily concerned with valuation and bio-securitization processes and with the role of the animals themselves in the commodification process. Offering a geographical approach to marketization, it attends to the spatialities involved in the marketization of animals. The thesis, for example, looks at the role of international incommensurability in valuation processes; how it is created in relation to country-specific situations and how it is overcome in order to allow for markets to operate across borders.

Classification is a commodity "stabilization" – a valuation – process. It makes the cows at the auction space comparable to each other, allowing for selection and exchange (Callon et al., 2002; Çalişkan & Callon, 2010). Breeding values are another, and decisive way to create comparability between farmed animals. They are not only calculated for cattle but also, for example, for pigs. Breeding values indicate "the probability that an individual will pass on specific heritable qualities to their offspring" (Holloway, Morris, Gilna, & Gibbs, 2009, p. 395). Breeding values are statistical estimates of the genetic value of animals. They are calculated for specific traits. In connection to dairy cattle they are calculated for traits such as milk yield and foot angle, and for both female and male animals. Breeding values are, for example, included in the auction catalogue. The catalogue is used by the farmers to select cows and also by the evaluation committee to classify the

cows at the auction spaces visited. They are also published in breeding catalogues, magazines and on company homepages used by farmers in order to select AI bulls. The committee's classification offers an additional selection tool for the farmers. The committee's judgments involve various criteria ranging from the cows' current milk yield, to their mothers' milk yield in a specific lactation period (which is published in the auction catalogue in connection to the pedigree information it includes), to the cows' own bodily appearance in regard to specific body parts, to their udder health status.

In the context of the trade in bovine genetics live animals and live animal body parts such as the bovine semen collected from bulls also have to be "made" biologically secure in order to become tradable because they can be host bodies for microbes which can spread, causing diseases that can harm humans, animals and economies alike. Bio-securitization processes therefore play a decisive role in the commodification of the particular lively commodities addressed in this thesis.

Importantly, breeding value calculations differ between breeds and often also between countries. Breeding values are therefore often not comparable across borders, which can create potential limitations in the context of the global exchange in bovine semen. Bio-securitization processes also differ between countries. Hence, the lively commodities traded are often neither comparable on the basis of their established capitalist value nor on their biosecurity status. Yet, they are traded.

Studying marketization in the context of the trade in cows at auction sales and the international trade in bull semen, my thesis especially engages with such limitations – the incommensurability in valuation and bio-securitization processes. It also addresses another limitation that can 'disturb' the commodification process: the animals themselves. Animals sometimes (obviously) do not behave according to market logics. At times they "escape" from the auction space because they feel "nervous" after having been transported from their home farm to the unfamiliar environment of the auction space. They are sentient living beings who live their lives. Therefore they also not only influence the commodification process. They make a difference to the commodification process per se.

Aim and research questions

The aim of this thesis is to study the workings of capitalist markets in order to advance our understandings of these crucial phenomena. This is done by focusing on the trade in animal genetics in the context of the dairy industry and with a particular focus on the Global North. My main concerns revolve around the taken-for-granted understandings that underlie the workings of these markets, and the potential future development of these markets as influenced by these understandings. The most important such understanding is

the idea that 'life itself', and especially animal life, is commodifiable. The aim of the thesis is not to criticize the industry by highlighting exploitative practices. Rather, it seeks to understand the mechanisms that allow for trade in animal genetics in the first place. My concerns in terms of the future development of these markets revolve around the deepening of the marketization of 'life itself' – the more intense exposure of 'life itself' to economic calculus (Collard & Dempsey, 2013; Cooper, 2008). It is therefore important to understand how these markets are enabled.

Callon conceptualises markets as assemblages or networks termed "agencement". This term, borrowed from Deleuze and Guattari, carries the meaning of "well equipped through the assemblage of heterogeneous elements" and of "agency". Agency, or the capacity to act, is understood as distributed. It is the "relational effect" of the practice of these sociotechnical networks (Berndt & Boeckler, 2009, p. 543; Çalişkan & Callon, 2010; Callon & Law, 2005; Law, 2009). Actor network theory (ANT), as a more-than-human ontology, conceives of the world and everything that exists as relationally enacted into being. This enactment or performance involves humans and non-humans. Nothing exists or has form outside the relations that constitute it. That means than nothing exists per se but is continuously created coming into existence (Barnes, 2008; Butler, 2010; Collard, 2013; Law, 2009; Nimmo, 2011).

Consequently, and in connection to Callon's ANT inspired approach to markets, animals form a constitutive element of the workings of markets. This approach helps to address animals as actors in their own right and, in so doing, it helps to challenge human centrism. That is, in the context of this thesis, the idea that agency primarily resides in humans. This idea is linked to the idea of "human exceptionalism". That is, following Haraway (2008, p. 11), that "humanity alone is not a spatial and temporal web of interspecies dependencies. Thus, to be human is to be on the opposite side of the Great Divide from all the others".

Drawing upon a performative approach to markets, Callon argues that markets are brought into being coordinated by market logics. Valuation processes that are enacted in the context of the trade in dairy genetics are performative in the sense that they bring forth and shape markets (Barnes, 2008; Collard, 2013; Çalişkan & Callon, 2010; Callon, 1998a, 1998b, 2007a, 2007b). They make animals become comparable to each other in specific ways, which allows for selection and exchange (Callon et al., 2002). Informed by the work of Callon, this thesis draws on a technical inflected approach to performativity in order to examine how animals are "made" commodities. That is, in approaching markets as material-semiotic networks, its analysis of how animals are made commodities does not focus on bodily, corporeal practices (see Haraway, 2008; Whatmore & Thorne, 2000). Rather, it engages with the practical enactment of calculative and other related

practices that, in the specific context of the market, make animals become tradable and, in so doing, allow for the workings of markets.

Arguably the key concepts related to "the question of how exactly markets as sociotechnical agencements are realized" (Berndt & Boeckler, 2009, p. 543) are the linked processes of framing and overflowing, the mechanisms which, for Callon, bring markets about. Callon conceptualises markets as "economic quasi-entities ever only stabilized temporarily by a double process of framing *and* overflowing" (Berndt & Boeckler 2009, p. 544, emphasis in original). Many framings make markets come to be. The process that stabilizes goods as commodities according to market logics is decisive (goods is not the right term to use for animals, but it is the process that is important). Valuation processes are key stabilization processes. Overflowings are moments of crisis in which the process of framing is disrupted, falters or fails and the instabilities and contradictions that always also form part of marketization come to the fore (Callon, 1998b, 2007a, 2007b, 2010; see also Berndt, 2015; Ouma, 2015).

In their work on nonhuman lively commodities, Collard and Dempsey (2013) are especially concerned with the role of the human/animal divide in the commodification of animals. Following this work, I approach the human/animal divide as "made" and as allowing for the commodification of animals. In the context of this thesis on the commodification or commodity stabilization of live animals and their live body parts this work helps foreground the significance of such relationships to the workings of markets in dairy genetics and to the commodification of nature more generally. Moreover, it helps foreground that animals, as actors in their own right, live a life. The thesis is based on multi-sited ethnographic and interview-based fieldwork mainly conducted in Germany and New Zealand between 2015 and 2018. The following research questions were formulated.

- How are dairy cows turned into commodities at the auction sales visited? How are the animals themselves involved in this process?

- How is the bovine semen that is collected from bulls "stabilized" as a commodity in order to allow for trade in bovine semen across borders, especially in the presence of differences in breeding value calculation?

- How is bovine semen "made" secure in order to allow for international trade, given that biosecurity standards differ between countries?

Outline of the thesis

This is an article-based thesis. It draws on three empirical studies that are presented in detail in Papers I-III. This cover essay situates this work within a wider research context. It also summarizes the key arguments, findings and contributions. This first chapter introduces the key issues that have been addressed. It also outlines my aim and research questions and it sketches out my theoretical approach. The six remaining chapters are structured as follows: Chapter two briefly outlines the development of the trade in bovine genetics. It also presents current trading figures to give an idea of the scope of this trade drawing upon the examples of Germany and New Zealand – the two cases that have been studied. Chapter three situates the thesis within the existing geographical literature. Chapter four presents my theoretical framework. Chapter five outlines my methodological approach. Chapter six summarizes Papers I-III. And chapter seven concludes by outlining the key arguments, findings and contributions.

Each article studies a different mechanism underpinning markets in dairy genetics. These mechanisms have been approached by combining conceptual insights from different fields of geographical research to advance our understandings of the workings of markets. To briefly summarize the Papers I-III: Drawing upon ethnographic and interview-based fieldwork conducted at cattle auctions in Germany, Paper I addresses the trade in breeding stock – cows – at auction sales. Focusing on how the cows exceed market logics, it studies the ways in which the unruliness of life challenges commodification, or commodity stabilization.

Papers II and III are similar in study design. Both address the global trade in bovine semen, building on multi-sited ethnographic and interview-based fieldwork conducted mainly in Germany and New Zealand. Studying the construction and negotiation of the paradoxical market dynamic of comparability and difference, Paper II focuses on measurement and abstraction in connection with country-specific differences in breeding value calculation. Markets need comparability (Callon et al., 2002; Robertson 2006, 2012b). But, as the paper shows, in the process of creating comparability – commensurability – difference – incommensurability – is established, which creates potential limits to exchange. These limits need to be overcome in order to allow for the global trade in bovine semen. Addressing multiple such processes, the paper demonstrates how markets emerge in a dynamic of comparability and difference which seems paradoxical at first.

Paper III attends to an additional commodity stabilization process. Exploring the securitization of bovine semen by focusing on the enactment of biosecurity standards, it shows how the circulation of capitalist value is enabled in spite of international incommensurability in bio-securitization processes. Addressing live animals and live animal body parts as potential host

bodies for microbes, Paper III engages with the particular lively commodities addressed as potential biosecurity risks.

The three studies all engage with how markets in dairy genetics are made to work in spite of not only pre-existing obstacles but of differences, resistances and instabilities – potential limitations – constructed in the process of trading itself. In so doing, they all engage with the iterative character of markets. Importantly, they do not all to the same extent examine valuation and bio-securitization processes and the role of the animals themselves in the commodification process. Rather they explore different aspects that allow for the trade of the particular nonhuman lively commodities addressed. Each paper thereby approaches the animals themselves in different ways. Paper I addresses cows as sentient living beings who sometimes act and behave in ways that appear as unruly or uncooperative in a market context. Paper II focuses on the bulls' reproductive genetics and on the calculative aspects that allow for the trade in bovine semen. Paper III approaches the bulls and the bovine semen collected from them as living organisms that can be potential host bodies for unwanted microbes. Papers II-III do not actively address the bulls themselves. Following the thesis' overarching approach, however, they still are addressed as actors in their own right. The trade in bovine semen implies the bodily absence of the bulls. It forms part of the commodity stabilization process. Papers II and III, in other words, engage with processes that "render" the bulls and the semen collected from them "passive" (Çalişkan & Callon, 2010). Paper I engages with "pacification" processes and unpacified cows. Pacification and stabilization do not necessarily imply passive and stable.

2. The global trade in bovine genetics

The global trade in bovine genetics comprises trade in live animals – breeding stock – and trade in bovine germplasm or live animal body parts – semen, ova and embryos. Cattle have been traded for a long time. They were considered a form of mobile wealth early on in their domestication (Colombino & Giaccaria, 2016). As Velten highlights (2007, p. 22, emphasis in original), the term 'cattle' originates from "the Middle English and Old Northern French *catel*, the late Latin *captale* and the Latin *capitale*, meaning 'capital' in the sense of chattel or chief property". The auction space is among the places where livestock, including breeding stock, are traded. We can give an indication of the scope of the trade in breeding stock using the example of Germany (the figures focus on exporting activities). In 2017, Germany exported 63 000 animals used for breeding to member states of the European Union (EU) and 79 000 such animals to non-EU countries (Bundesministerium für Ernährung und Landwirtschaft, 2020a).

The trade in frozen germplasm, on the other hand, developed in the beginning of the 20th century. Following Parry (2015, p. 55), its origin can be traced back to the first experiments conducted in the middle of the seventeenth century in order to investigate "how animals are generated". The practice of artificial insemination developed in connection to these experiments. The most significant breakthroughs in the preservation of tissue at ultra-low temperatures occurred in the 1930s. From then on mammalian cells could be stored and archived for years. These developments, as Parry notes further (2015, p. 57), "fundamentally altered the historical dynamics of the cellular life cycle by enabling tissues, but in particular gametes, to become detached and disassociated from the bodies that produced them". They take up "their own trajectory, their own 'career' as Appadurai would call it", Parry adds.

The bovine semen collected from AI bulls takes up its own career. Collected, processed, and stored in liquid nitrogen in the form of semen straws it can be kept alive for a long time and traded across large distances. Yet, in taking up its own commodity career, it still *is* associated with the body that produced it. Breeding catalogues, for example, show pictures of the bulls and farmers as well as employees working for the different genetics trading companies interviewed in the context of this thesis made comments about them. In short, the bovine semen collected is made tradable through detachment but *also* because it is still associated with the body that produced it (see also Parry, 2015 for an elaboration on this point in connection to the "mar-

ketization" of human sperm). This thesis does not engage with the technical-mechanical aspects of detachment. Examining the valuation process, it focuses on 'association' (Paper II).

The rate of artificial insemination is high in the Global North. In Europe, around 90 percent of all dairy cows are artificially inseminated (Spengler Neff & Ivemeyer, 2016). In the case of Germany, with a dairy cow population of around 4 million animals (Bundesministerium für Ernährung und Landwirtschaft, 2020b), that is 3.6 million inseminations per year. Germany has the highest number of dairy cows in the European Union. It is also the EU's largest milk producer (Bundesministerium für Ernährung und Landwirtschaft, 2020c, 2020d). The EU's total dairy cow population consists of around 23 million animals (Bundesministerium für Ernährung und Landwirtschaft, 2020c, figures from 2017). That means 20 million inseminations per year. The figures are not complete. They do not consider that female animals sometimes have to be inseminated more than one time in order to get them pregnant. They also do not include heifers – female animals that have not yet had their first calf and are, hence, not counted as dairy cows. But these numbers give an idea of the scope of the trade in bovine semen. Usually one dose of semen is used to inseminate one cow.

New Zealand also has a high share of artificial insemination. In the dairying season 2015/2016, the country's total cow population consisted of almost 5 million animals, and 3.55 million animals were artificially inseminated (Livestock Improvement Corporation Limited & DairyNZ, 2016). New Zealand is a dairy country (like Germany). Its dairy sector has been growing. The statistics for the season 2015/2016 show a continuous increase in milk processing for the last 35 seasons. The milk production volume was 47 percent higher than in the season 2005/2006 (Livestock Improvement Corporation Limited & DairyNZ, 2016). Importantly, and as outlined in detail in Paper II, the New Zealand dairy sector differs in various respects from those in other countries. These differences shape the trade in bovine semen by influencing the way in which breeding value calculations are set up. The New Zealand calculations differ to a large extent from those in other countries, which makes the country an interesting case study because breeding values differ in significant ways which creates potential limits to exchange that have to be overcome in order to allow for the operation of transnational markets. Breeding values are primarily calculated by Global North countries. New Zealand's biosecurity standards for imported bovine germplasm also include "risk organisms" (Ministry of Agriculture and Forestry, 2011) that other countries do not consider as biosecurity risks; and still bovine semen is traded.

The auction spaces visited in Germany hold an EU approval. In other words, the breeding society organising the auction sales follows EU regulations which allows for the trade in cattle within the European Union. Engaging with Germany as a case study allows us to address the national, the EU-

wide and the international trade in bovine genetics. For reasons outlined in detail below (chapter five), the research in Germany focused on one particular German federal state.

3. Research context

This chapter situates the thesis within a wider research context. The chapter is structured around the four key themes addressed in the papers: the commodification of animals; the idea of the unruly commodity; the construction and negotiation of paradoxical market dynamics; the entanglement of biosecurity and capitalism. The chapter discusses those themes in relation to the following strands of research in human geography: on "marketization", on the commodification of nature, on nonhuman lively commodities, on animal geographies, and on biosecurity. In so doing, the chapter begins to sketch out how the thesis contributes to the existing research literature.

The commodification of animals

The "geographies of marketization" literature has been advanced by scholars such as Christian Berndt and Marc Boeckler (2009, 2011, 2012; Berndt, 2013, 2015; Ouma, 2015; Ouma, Boeckler, & Lindner, 2013; see also Bair & Werner, 2011; Bair, Berndt, Boeckler, & Werner, 2013). Drawing upon the concept of marketization developed by Michel Callon, this literature uses a performative approach to the market economy in order to study the workings of markets (1998a, 1998b, 2007a, 2007b; Callon et al., 2002; Callon & Muniesa, 2005; Çalışkan & Callon, 2009, 2010; see also MacKenzie, 2007; MacKenzie, Muniesa, Siu, 2007; Mitchell, 2007). Looking at how markets are practically enacted, it examines how concrete markets come to be.

In one of their seminal contributions to the field of economic geography, Berndt and Boeckler contrast performative approaches to the market economy with neoclassical and political economic inspired approaches by outlining the following key difference (2009, p. 542, emphasis in original):

> For neoclassical economic geographers the market does not constitute an object of inquiry. The market is no problem; it solves problems. For political economy the reverse is true with the same consequences. Here, the market is the problem, creating as it does inequality through uneven accumulation processes. The market is therefore an object of critique and resistance rather than only a simple object of study. … But what if the market neither is a problem nor does it solve any problems but is simply real – under specific conditions? This is the argument of Michel Callon: markets are real, *homo economicus* does exist and rational calculation constantly takes place.

Following Callon's approach to the market economy, the geographical literature on marketization studies how real (concrete) markets come to be. Scholars have looked at emissions trading markets (Cooper, 2015) and the maquiladora industry in connection to regional development (Berndt, 2013). But the main focus has been on the agricultural sector, including the nexus of agricultural and financial markets (Berndt & Boeckler, 2009, 2011, 2012; Muellerleile, 2013, 2015; Ouma, 2010, 2012, 2015; Ouma et al., 2013; see also Hébert, 2010, 2014 for a Callonian inspired study on fish). Such studies have examined market-making in the Global South (e.g., Ouma, 2015) and in terms of the relation between the Global South and the Global North (e.g., Berndt & Boeckler, 2011).

Linking the idea of framing and overflowing to the question of spatial borders, Berndt and Boeckler have developed a particular geographical reading of Callon's concept. They use the notion of b/ordering to demonstrate that borders (such as that between the Global South and the Global North) are drawn in and through markets, which is to say, through the process of trading – border crossing – itself (see also Berndt & Boeckler, 2012; Berndt, 2013). Drawing borders simultaneously means producing differences. Looking at how particular market mechanisms produce uneven geographies – market insides and outsides – authors such as Berndt (2013) and Ouma (2015) understand the workings of markets as problematic. Yet, drawing from Callon and using the theory of performativity, the problematic of inequalities is approached in different ways.

The work on marketization has shown a particular concern with framings – processes that stabilize markets according to the dominant market model – and, to a lesser extent, overflowings – moments of crisis in which framings falter or fail and the instabilities and contradictions that always also form part of marketization come to the fore (Berndt, 2015; Ouma, 2015; see also Butler, 2010; Overdevest, 2011 on economic sociology).

The study by Ouma and collaborators (2013) of the Ghanaian agro-export markets exemplifies the literature's approach to the study of markets. In this study the authors demonstrate how the global commodity chain approach has mutated from a tool that has been used in order to study the production of inequality in the global economy to an instrument of development policy that makes markets. In other words, they show how the concept of value chains has become performative. The authors consider three key, interrelated framings. Those three framings have been presented by Berndt and Boeckler (2009, 2012) as the key processes that bring markets about (see also Çalışkan & Callon, 2010).

The first such framing involves the process that converts "goods into *commodities*" (Berndt & Boeckler, 2012, p. 205). Following Callon and collaborators, "qualification" and the related process of "singularization" are key such commodity stabilization – framing – processes. In the process, stable tradable objects are constructed by emphasizing particular "qualities"

(Callon et al., 2002). Following Berndt and Boeckler further, the second framing involves "the formatting of calculative *agencies*". The third framing involves the "[i]dentification of the formative settings through which *encounters* between goods and agencies are organized" (emphasis in original).

This thesis focuses on the process by which animals are turned into commodities. In contrast to previous studies, it looks at the commodity stabilization of a nonhuman lively commodity. Following Collard and Dempsey (2013), the capitalist value of nonhuman lively commodities is derived from them remaining alive and/or promising future life. The value of dairy cows is derived from them remaining alive. The value of bovine semen is derived from its promising future life for generations of cattle. Previous studies on marketization have addressed the trade in horticultural products such as tomatoes and mangoes (Berndt & Boeckler, 2011; Ouma, 2015; Ouma et al., 2013). Those are what Collard and Dempsey (2013, p. 2684) term "dead commodities derived from living things" which, according to the authors, include "agricultural commodities like meats, fruits, vegetables, and grains".

This thesis adds to previous research by studying marketization in the context of a different type of agricultural commodity and by focusing on the Global North. Studying marketization in a different geographical context and by looking at a different type of agricultural commodity, it engages with the particularities of the commodity stabilization of nonhuman – animal – life. In so doing, it follows Castree who argued that the process of commodification "might operate rather *differently* depending on which particular natures are being commodified" (2003, p. 275, emphasis in original). This difference also revolves around the fact that the 'goods' that are turned into commodities in the context of this study are sentient living beings who make a difference to the process of commodification per se *because* they are sentient living beings (Collard & Dempsey, 2013; Collard, 2014).

The growing literature on nonhuman lively commodities focuses on studying the commodification of nonhuman life and especially of animals. Rosemary Collard and Jessica Dempsey have developed the idea of the nonhuman lively commodity in connection to their work on exotic pet trade (Collard) and on market-based conservation in the context of markets in ecosystem services (Dempsey) (Collard 2014; Collard & Dempsey, 2013, 2016, 2017; Collard & Gillespie, 2015a; see also Bair et al., 2013). Collard (2014, p. 153) uses the term lively and not living "because it is not merely being alive that is integral to their being companion commodities, but also liveliness, which is to say, active demonstrations of being full of life – eating a mouse, flapping around a cage, or even blinking eyelids." Cows and bulls are not companion commodities in the sense of pets (although they might be pets for some humans). But they also have to be lively and not merely alive. Cows, for example, have to be able to walk up to the fodder table, to the trough and to the milking machine. They cannot simply be alive. In that sense it is also not the cows' reproductive abilities alone that make them

become commodities (although cows can be reduced to this ability to a certain degree). AI bulls also have to be active, and the bovine semen collected from them also has to show a certain degree of activity or liveliness. There is a motility threshold that has to be met in order for the batches of semen collected to be allowed to be traded. At least the collection facility visited in the context of this thesis follows a threshold. The term liveliness also addresses the flipside of the commodification of animal life. The liveliness of a lively commodity can be diminished profoundly, as Collard (2014) highlights. Moreover, the term involves an approach to animals as animal subjects.

Several authors have picked up on the idea of the nonhuman lively commodity. Addressing the sphere of tourism and biodiversity conservation in India, Barua (2016, 2017) has approached elephants and lions as nonhuman lively commodities. Colombino and Giaccaria (2016) have addressed the commercialization of bull semen in connection to their work on the relation between life and death in biocapitalism, and Pütz (2019) has approached wild horses as nonhuman lively commodities.

Scholars in this field work at the intersection of different strands of geographical research. Having advanced the idea of the *nonhuman* lively commodity, Collard and Dempsey (2013) have been inspired by the literature on live *human* commodities and especially by the work by Parry on bodily commodification (2008, 2012). Scholars have also drawn upon the political economies of nature literature, more-than-human geography, and the animal geographies literature in order to approach the commodification of animal life. Working at the intersection of both literatures and informed by the writings of Haraway and Marx, Barua (2016) proposes a relational and less humanist approach to commodification and accumulation in his work on the commodification of animals. Other scholars have also been inspired by literatures beyond the discipline of human geography. Colombino and Giaccaria (2016), for example, have drawn upon work by Agamben and Shukin in order to approach the relation between life and death in biocapitalism in the context of the commercialisation of bull semen. Using biopower as a conceptual lens, they show how death rather than life is productive in biocapitalism. Pütz (2019), on the other hand, draws upon the concept of marketization developed by Callon and the idea of "encounter value" advanced by Haraway (2008) in order to approach the commodification of wild horses, highlighting the role of human-animal encounters. In seeking to advance a more-than-human approach to value, Pütz focuses on valuation processes. But, in so doing, the human-animal relations that allow for trade fall by the wayside. In other words, the fact that animals are bought and sold is not addressed.

My thesis connects, above all, to the work of Collard and Dempsey. In their writings on the commodification of nonhuman life, the authors focus on the role of species hierarchies – the ordering processes that posit fundamental differences between the trade in live human and live nonhuman commodities (Collard & Dempsey, 2013, 2017; compare Greenhough, Parry, Dyck,

& Brown, 2015; Parry, Greenhough, Brown, & Dyck, 2015; Parry, 2015). Collard and Dempsey argue that the human/animal divide authorizes animals to be bought and sold. In this context, they address the issue of value and problematize power relations and violence against animals (see also Collard, 2014; Collard & Gillespie, 2015a, 2015b). As the authors write, they have turned to value "to try and understand why capitalism is so destructive for nonhuman life" (2017, p. 315; see also Bigger & Robertson, 2017 on value and exploitation).

Writings by the feminist science studies and human-animal scholar Donna Haraway have been influential. Drawing upon a performative approach to markets, the work by Collard is also informed by the writings of Callon and other economic sociologists. Engaging especially with the idea of entanglement and disentanglement in order to address the making and unmaking of exotic pets, this work focused on the diminished life of exotic pets who live a life disentangled from their "wild life" (Collard, 2013, 2014; Collard & Dempsey, 2013; Collard & Gillespie, 2015a; see also Collard, 2014 for a discussion on the idea of wilderness).

In their collaborative work on critical animal geographies, Collard and Gillespie (2015a) also approach cows as lively commodities. Similar to Collard, Gillespie engages with the auction space as a place that reveals the subordination and exploitation of animals. Focusing on power imbalances between animals and humans in the context of the dairy industry, Gillespie (2014) draws upon the concepts of sex and gender in order to analyse the commodification of cows and bulls in the dairy industry.

In contrast to those previous studies, this thesis is focused less on developing a more-than-human approach to value. It is also less concerned with power imbalances, exploitation and the question of what the commodification process means for the animals themselves (e.g., Collard, 2014). My thesis focuses more on the iterative character of markets. In so doing, it looks at how market iterations are made possible through the workings of the human/animal divide. Nonetheless, the thesis acknowledges the workings of power imbalances and the violence against animals that these imbalances can bring about.

The auction space is a key site of animal marketization in this thesis (Paper I). In economic sociology, the auction space has also been addressed. Notably, it has been approached as a space in which the perfect market model is realized. In her famous study of the strawberry auction at Fontaines-en-Sologne, Garcia-Parpet suggests (2007, p. 20) that this market is "a concrete realization of the pure model of perfect competition, a model that occupies pride of place in economic theory" (see also Barnes, 2008; Callon 1998a, 2007b; Law, 2009). This thesis, by contrast, does not focus on market perfection. Through its examination of cow auctions, it focuses on market *im*perfection and the crisis potential that always haunts marketization.

The unruly commodity

The geographical literature on marketization, as mentioned, has not substantially addressed the instabilities, resistance and crisis moments inherent to marketization. But there are exceptions. In his study of Ghanaian agro-export markets, Ouma (2015) addresses overflowings as well as framings. Exemplifying how crisis forms part of marketization, Ouma (2015, p. 176) shows how "even nature may 'refuse' to be turned into resources". The "precarious commodities" addressed in his study are mango trees. Stating that framing is "a delicate process which can easily get out of control", Berndt and Boeckler (2011, p. 1073) also engage with crisis moments. In their study of the cross-border trade in tomatoes between the Global South and the Global North, the authors address the example of a Salmonella outbreak in relation to the trade between Mexico and the US. Framing this outbreak as an overflow, the authors highlight that sanitary risks such as diseases caused by Salmonella always form part of food production and processing. As Berndt (2015, p. 1870) has stated elsewhere, it is important not to "assume that the market rationality is put to work in a unilinear way. …[M]arkets are always in the making, never complete and fully stable, and notoriously prone to fail".

Scholars working on the political economies of nature, on the other hand, have widely studied capitalism's crisis tendencies, including by engaging with various forms of "unruly" or "uncooperative" natures. Bakker (2004, 2007) has approached water as an uncooperative commodity in her study of the privatization of water in England and Wales. Borrowing the term "uncooperative commodity" from Bakker, Bridge (2004) has approached natural gas as uncooperative, and Robertson has looked at nature's resistance to commodification in the context of markets in ecosystem services (2004, 2006, 2012a, 2012b; see also Bakker, 2010; Braun, 2006, 2008; Castree, 2003 for examples).

As Bakker (2010, p. 718) has highlighted, this literature usually frames nature's agency "as a set of constraints upon human actions, and specifically as a set of limits to capital accumulation". The idea of "unruliness" or "uncooperativeness" implies the existence of a set of rules. Following Robertson, "'uncooperativeness' only appears within the context of specific social projects which require cooperation" (2012b, p. 380, in reference to McCarthy, 2005; Bridge, 2002). Hence, and similar to the marketization literature, this literature approaches nature's unruliness not as intrinsic to nature but as produced in the process of commodification itself. Following Robertson again (2004, p. 366):

> [W]hen ecological phenomena factor into the stabilization or destabilization of capital relations, they never do so as ecological phenomena per se. They

> do so only after going through a process of coding by which they are made legible to the logic of capital.

This idea connects to the concept of framing and overflowing. It also shows that processes of coding – of framing – are important to consider when approaching nature's unruliness. For nature is never unruly per se. It becomes unruly in the process of commodification – of commodity stabilization. Yet, and in contrast to the literature on marketization, the political economies of nature literature tends not to frame the more-than-human as a constitutive element of economic life. Following Braun (2008, p. 668), "at the very moment in which the 'liveliness' of non-human life is acknowledged, it is simultaneously circumscribed". In relation to this critique, Bakker writes (2010, p. 718):

> Accepting Braun's critique… implies that scholars of neoliberal nature should adopt a non-anthropocentric view of the agency of nature, and interrogate the status of non-humans as political subjects. In this way, we might produce better accounts of the interrelationships between ecological processes, non-humans and humans – whereby agency is both enabled and constrained. And we would be more sensitive to the pitfalls of characterizations of nature as a passive backdrop to (or victim of) political economic forces.

The commodification of nature is initiated by humans (see also Bakker's earlier comment on how nature is being framed as a constraint upon human action). But, to paraphrase Bakker, characterizing nature as passive or as a victim of political economic forces strips it of its agency.

Scholars working in the field of animal geographies offer a different approach. They have studied how humans and nonhuman animals co-construct realities in multiple contexts and from a non-anthropocentric perspective. In order to include animals' perspective and to account for their agency, such scholarship has conceptually been informed by actor network theory (ANT) and by feminist material semiotics, especially by the writings by Haraway on companion species (2008). In extending ANT to animals it has been possible to recognize "their agencies in the practices of everyday life", Lorimer and Srinivasan note (2013, p. 336; see also Buller, 2014). A study by Whatmore and Thorne (2000) on the spatial formations of wildlife exchange exemplifies this approach. The authors engage with "wildlife as a relational achievement spun between people and animals, plants and soils, documents and devices in heterogeneous social networks which are performed in and through multiple places and fluid ecologies" (2000, p. 187). Methodologically, scholars have developed techniques to conduct research in what Haraway has termed multi-species "contact zones", for example, by conjoining ethnographic and ethological methods (Buller, 2014; Lorimer & Srinivasan, 2013; see Lorimer, 2010; Hodgetts & Lorimer, 2015 for examples; see also Buller, 2013, Collard & Gillespie, 2015a, 2015b; Lulka, 2015; Philo & Wilbert,

2000; Urbanik, 2012 for literature reviews; see also Whatmore, 2006 on more-than-human geographies). Multi-species ethnography is one way in which animal geographers and others have extended the repertoire of ethnographic means. Multi-species ethnography accounts for animal presence and agency, not only theoretically but also methodologically (Buller, 2014).

But in researching the co-construction of multiple realities, the animal geographies literature has failed to address the question of how markets are co-constructed. It has also engaged only minimally with how animals 'resist' commodification (although see Risan, 2005). My thesis adds to previous work by specifically considering the market sphere. In so doing, it is explicitly informed by Robertson's (2004) reminder that it is never as ecological phenomena per se that such phenomena factor into the stabilization and destabilization of capitalist relations. "They do so only after going through a process of coding". Hence, in approaching markets as co-constructed, this thesis also takes into account agential divides between humans and animals that make animals factor into the stabilization and destabilization of capitalist relations.

The paradoxical dynamics of markets

The construction of paradoxical market dynamics has been studied by scholars within and beyond the discipline of human geography. In their study of "boosted bodies", for example, which can be placed in the animal geographies literature, Holloway and Morris (2008) engage with the construction of complexities though simplification in the context of the representation of animals through breeding values. Focusing on sheep and beef cattle breeding in the UK, they examine a notable shift in knowledge-practices related to new techniques of genetic assessment and evaluation. This shift, they (2008, p. 1711) note, is "bound up with the production of particular sorts of knowledge-practice surrounding life, and with the production of particular sorts of representation of life". Addressing the interplay between simplicity and complexity, the authors focus on the spatialities of this interplay, for example, by looking at the relation between 'lay' and 'scientific' knowledge-practices and the respective spatialities involved. Drawing from Mol and Law (2002), Holloway and Morris note (2008, pp. 1711-1712, emphasis in original):

> For Mol and Law, the coordinated meetings of different simplifications or versions of reality (e.g. of the body) potentially produce new complexities, as different versions may be incommensurate, intersecting or interfering with each other: 'Somewhere in the interferences something crucial happens, for although a single simplification *reduces* complexity, at the places where different simplifications meet, complexity is created, emerging where various

> modes of ordering come together and add up comfortably or in tension, or both.

In her study of salmon fisheries in Alaska, meanwhile, Hébert (2010) analyses the paradox of sustainability and the quality commodity drawing upon the example of wild salmon and farmed salmon. Using the idea of singularization developed by Callon and colleagues (2002), the author (2010, p. 555) suggests that "[i]n order for wild salmon to be made distinctive, and set apart from farmed salmon in particular, it must be remade to mirror a model largely established by the farmed salmon industry". The market paradox addressed in this study revolves around the idea that in order to become distinctive, wild salmon has to be "marketized" according to ideas derived from an industry *against* which the producers of wild salmon simultaneously seek to position themselves.

Berndt and Boeckler (2011) also address the construction of a market paradox in their work on the international trade in tomatoes. Looking at the processes by which the free-trade logic translates into market realities, they engage with the paradox of global connectivity, oscillating between border crossing and drawing. They approach this paradox by studying the border between the Global South and the Global North in the context of global commodity chains. The authors' key argument is that the border between the Global South and the Global North is constructed in and through the practical performance of the free-trade argument which, simultaneously, revolves around the erasure of borders.

The political economies of nature literature has also engaged with paradoxical market dynamics. Focusing on how capitalism oscillates between comparability and difference, Robertson shows how abstraction is needed to enable trade but how it simultaneously also produces potential limits to exchange. Addressing difficulties and differences in relation to classification and categorization processes in the context of the commodification of nature, he looks especially at measurement in abstraction. In reference to Neil Smith's discussion of capitalism's general crisis tendency (2008[1990]), Robertson argues that "the creation of equalisable value-bearing abstractions requires, and produces, a differentiated landscape that may recursively threaten accumulation" (2012a, p. 396; see also Robertson, 2004).

This thesis adds to previous research on the political economies of nature, and especially in connection to Robertson's work, by looking at how capitalism's crisis tendency is established *and* overcome. Paper II does so by focusing on how the paradoxical dynamic of comparability and difference iterates. It addresses this iteration by exploring processes of abstraction, or, as Callon might say, the construction of qualities through breeding value calculation and other calculative tools that help to stabilize bovine semen as a commodity. Drawing upon the idea of qualification and especially of singularization, it engages with multiple dimensions of comparability and difference which,

simultaneously, construct a dynamic of simplification and complexity (Mol & Law, 2002). In this context it also attends to the idea that markets work on the basis of mechanisms that make "the ordering of appearances … appear as order itself" in the eyes of those subject to them (Robertson, 2012a, p. 397; see also Berndt & Boeckler, 2011; Mitchell, 1988). In other words, it engages with taken-for-granted understandings that allow for market iterations and that revolve around our consent to markets and their rules.

In its focus on measurement (statistical calculations) in abstraction, Paper II makes a unique contribution to the literature on geographies of marketization. Using the example of breeding value calculation, the thesis also links to and advances upon studies in the field of animal geographies. This literature has addressed animal breeding in the context of the agricultural sector and by looking at different breeding techniques (Gibbs, Holloway, Gilna, & Morris, 2009; Holloway, 2005; Holloway & Morris, 2008, 2012, 2014; Holloway et al., 2009, 2011; Morris & Holloway, 2009; see also Calvert, 2013; Grasseni, 2005, 2007; Lonkila, 2017 for studies on animal breeding and breeding value). Holloway and colleagues, for instance, have engaged with classification and the role of breeding values focusing on knowledge production, the interplay between different knowledges and the reconfiguration of different agricultural spheres (e.g. changes in institutional settings). They have also addressed issues of control and population improvement (see also Lorimer & Srinivasan, 2013; Parry, 2015 on the work by Holloway and colleagues). But such studies have barely considered the workings of markets per se, still less their paradoxical qualities.

Biosecurity and capitalism

Following Bingham and collaborators (2008, p. 1528), biosecurity might be defined as "making life safe". The biosecurity literature has addressed the issue of making life safe in different contexts and it has studied biosecurity in multiple ways (Barker, 2015; see also Bingham, Enticott, & Hinchliffe, 2008; Hinchcliffe & Bingham, 2008; Enticott, 2014 for overviews of different approaches to biosecurity). Similar to the geographical literature on marketization, it examines regulatory ordering processes, focusing on the regulation of plant, animal and microbial movements (Bingham et al., 2008). Particular attention has been paid to borders and boundaries (Barker, 2008; 2015; Hinchcliffe, Allen, Lavau, Bingham, & Carter, 2013; Law, 2006; Phillips, 2013). Several authors have engaged with New Zealand in their work on biosecurity (Barker, 2015; Enticott, 2014, 2016, 2017).

The literature has important conceptual links to that on more-than-human geographies. Phillips' study (2013) of Australia's pest control measurements in regard to the fruit fly – an agricultural pest – exemplifies such links: in order to conceptualise the country's biosecurity measures, the author draws

upon a more-than-human approach. Phillips theorizes biosecurity as an "ongoing, enacted achievement sustained (or not) by everyday and eventful interactions of heterogeneous spaces, strategies, and participants – human and nonhuman" (2013, p. 1679). Other scholars have also approached biosecurity realms as assemblages, composites and networks constituted of humans and non-humans. Biosecurity, disease and the body have become understood as relational achievements (Barker, 2015; see Hinchcliffe et al., 2013 for an example).

In a helpful overview, Barker (2015) approaches the biosecurity literature through four different modes of circulation: trade and travel, viruses, information and capital. The author emphasizes, however, that capital as a mode of circulation has been addressed only minimally.

Focusing on the question of how biosecurity standards regulate the circulation of capitalist value (Paper III), this thesis expands upon existing research theoretically as well as methodologically. The biosecurity literature has certainly used multi-sited approaches. But studies have focused on one country (e.g., Hinchcliffe et al., 2013; Mather & Marshall, 2011). This thesis studies securitization processes across multiple sites and countries. In so doing, it addresses spatial differences in biosecurity practices. The 2020 corona crisis has made visible the consequences of country-specific differences in biosecurity practices on especially human travelling patterns. Humans serve as host bodies for this specific virus and they can, consequently, carry and spread the virus. Paper III addresses a live animal body part as a host body for microbes. When being traded, it can spread viruses and bacteria causing disease that can harm humans, animals and economies alike. It is therefore "made" secure in order to allow for trade. But bio-securitization differs between countries, shaping the travelling patterns of the batches of semen collected. How exactly? Addressing this question, Paper III also engages with another issue that previous studies on biosecurity and especially on agricultural biosecurity have not discussed: the fact that biosecurity practices are implemented in order to make animals – livestock – secure for the trade in agricultural products.

Research on marketization has looked at the role of public and private food quality and food safety standards in the context of the trade in agricultural products (Berndt & Boeckler, 2011; 2012; Ouma, 2010, 2012, 2015; Ouma et al., 2013; see also Bair & Werner, 2011; see also Hébert, 2010, 2014 on fish). But those studies have not examined how microbial and animal movements (e.g. the movements of fruit flies) are regulated *specifically* in order to allow for such trade to work. This is the focus of Paper III, which conceptualises biosecurity standards as an additional framing process. It thereby examines what Barker has described as follows (2015, p. 358): "Biosecurity must negotiate a balance between too much and too little regulation, as in the spaces where it operates it is not the only concern, competing with a manifold of circulations, driven by different forces" including "the

sustaining of economies"…. "[T]hese flows cannot be simply halted or suppressed if liberal life is to survive and flourish" (see also Bingham et al., 2008; Hinchcliffe & Bingham, 2008 for a similar argument).

Paper III approaches the continuous circulation of bovine semen and, hence, of capitalist value flows in markets in bovine genetics by also attending to our relation to animals in the value form. In other words, it addresses the fact that animals and their body parts are made secure in order to become tradable across the globe. This approach is informed by scholars working on the political economies of nature who also address value as relational (Bigger & Robertson, 2017; Robertson, 2012a). In reference to Marx, Robertson and Wainwright state (2013, p. 300); "[v]alue is essentially relational". This also includes our relation to the natural world. As the authors note further:

> In capitalist society the attempt is made to place everything, even our relation to the natural world, in the value form native to capital. This attempt, however, can never be completed, and Marx's theory of value also draws our attention to the fact that a social form of value could exist in which the wealth of our relationship with the natural world is not reduced to exchange value.

The marketization literature engages less with this type of relationality despite its focus on valuation processes. Neither, as mentioned, has the biosecurity literature engaged with this relationality. Looking at how valuation – qualification – processes and other framings allow for the circulation of capitalist value in markets in bovine genetics, this thesis triangulates between existing work on the political economies of nature, on marketization and on lively commodities, but also on biosecurity. It heeds Bigger and Robertson, who, in reference to Christophers (2014), highlight "a good opportunity for collaboration between Science and Technology Studies (STS) [performative approaches] and political economy", stating that (2017, p. 72):

> We point to a similar synthesis for thinking about value(s) by suggesting that political economy and STS …provide crucial perspectives on practices and regimes of valuation. …This approach recognizes that it is not only metrics or only exploitation that make social natures: both are essential parts of a fully functioning capitalist regime of valuation…A combined STS/Marxian approach to value is powerful because Marx′s concept encompasses economic and moral valences of value, while valuation studies and STS allow for sophisticated understandings of semiotic valence, the task of creating distinctions between things, performed by people with specific motivations and in particular contexts.

This thesis does not focus on exploitation. Rather it engages with the continuous circulation of capitalist value by focusing on how our relationship to the natural world and especially to other sentient living beings enables for market iterations which, in turn, are made possible on the basis of valuations and other framings. The task of "creating distinctions between things", to

refer back to the quote above, also includes creating a distinction between humans and animals; between those that are capable of valuing and those that are being valued.

4. Theoretical approach

The thesis builds upon an ontology that conceives of the world as co-constructed and that rejects the binary opposition between humans and non-humans. Humans are understood as one of many heterogeneous elements that bring forth and shape the world, but not necessarily as the key element. Inspired by actor network theory and material semiotics more generally, the thesis follows the assumption that nothing has reality outside the webs of relations that enact it. The main point of departure for the thesis's theoretical framework is the work of actor network theorist and economic sociologist Michel Callon, on marketization.

Actor network theory (ANT) originated in the late 1970s and early 1980s. The term actor network was devised by Callon. It appeared in the early 1980s (Law, 2009). Callon also extended the actor network approach to the economic field (Barnes, 2008; Berndt & Boeckler, 2009; Çalişkan & Callon 2009; 2010; Callon & Muniesa, 2005). Law defines ANT as (2009, p. 141):

> a disparate family of material-semiotic tools, sensibilities, and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterize the webs and the practices that carry them. Like other material-semiotic approaches, the actor network approach thus describes the enactment of materially and discursively heterogeneous relations that produce and reshuffle all kinds of actors.

Such enactments or performances are productive. "To say something is performative, … is to say it brings forth and shapes the world" (Collard, 2013, p. 44, in reference to Barnes, 2008). Consequently, to understand markets, following Law again, "we need to trace how the webs of heterogeneous material and social practices produce them. It is *these* that are performative, that generate realities" (2009, p. 151, emphasis in original). The idea of performativity informs the work of Callon and other economic sociologists (e.g., MacKenzie, 2007; Mitchell, 2007). In the context of this work a key argument has been that economics is performative. According to these scholars, market models do not so much depict the reality they seek to describe; they make it become real (e.g., Callon, 1998a; 2007b; Mackenzie, 2007; see also Butler, 2010 on economic sociology).

This thesis especially draws upon the idea that markets are enacted and, in the process, continuously reproduced. Law gives the following example in relation to work by Garcia-Parpet on the strawberry auction sale (2009, p. 151): "Buyers, sellers, noticeboards, strawberries, spatial arrangements, economic theories, and rules of conduct – all of these assemble and together enact a set of practices that make a more or less precarious reality." Specifically, this thesis focuses on processes of *stabilization* – calculative practices (valuation) and other related practices (biosecurity) that help to make animals become tradable; that detach them from one context (e.g. seller) and attach them to another (e.g. buyer). In the context of the trade in animal genetics, for example, animals and their live body parts need to be "made" biologically secure in order to be traded.

A key commodity stabilization – framing – process is qualification. In this process, certain characteristics – qualities – of goods are made visible. As Çalişkan and Callon (2010, pp. 5-6) explain, goods have to be rendered passive in order to allow for the operation of markets. They may not "express novelty or unexpected characteristics". For, if they do, they are not calculable. Qualification thus entails the reduction of goods "from wild unknowns to things with fixed qualities", which serves "to disentangle things from their network of connections" (in reference to Thomas, 1991). Goods, in short, need to be "transformed from entangled beings into passive things". This is integral to marketization.

Crucially, qualification positions goods "in relation" to each other. And in the process, value is established – again, relationally. Qualification *is* a valuation process. It allows for comparison, selection and exchange (Callon et al., 2002). Value is not absolute. Neither is it inherent in 'things' such as wetlands, trees, salmon and animal body parts (see also Bigger & Robertson, 2017; Robertson, 2004, 2006, 2012a). Those 'things' only come to bear value by virtue of processes of qualification.

A key mechanism of qualification is singularization (Callon et al., 2002; see also Berndt & Boeckler, 2011). Singularization, Callon suggests, is at the heart of economic competition and market organisation. He conceptualises the construction and mobilisation of commodities as a double process of similitude and dissimilitude. Commodities have to be similar in order to be comparable. Yet a commodity has to be singularized in order to be distinguished from other commodities. Thus, the perception of singularity operates against the background of comparability. "Different and similar, singular and comparable, such is the paradoxical nature of [the commodity] constituting the dynamics of markets" (Callon et al., 2002, p. 201).

According to Callon, a commodity can be defined by a combination of characteristics. It is those characteristics which establish singularity. The same characteristics can be used to describe other commodities. Consequently, a commodity is positioned in a space of commodities, "in a system of

differences and similarities, of distinct yet connected categories" (Callon et al., 2002, p. 198).

I have relied on this conceptualization to approach the marketing strategies of companies trading bovine genetics (Paper II). These companies use 'bull proofs' in order to market their bulls. These proofs comprise a list of characteristics, including total merit indices, production traits, and conformation traits. These characteristics (breeding values) make the bulls comparable to each other. They describe the same traits. Yet the numerical indices differ.

A particular focus has been on contextual – geographical – differences in singularization processes. In the context of the international trade in dairy genetics, singularization processes differ between companies. But they also often differ between countries. Breeding values are key tools used in selective breeding. They are calculated following breeding goals. Methods vary. Because calculated in different ways, breeding values are often not comparable across borders. Those differences have to be overcome in order to allow for trade. For, following Callon and collaborators, while commodities need to be singularized in order to be distinguished from other commodities, the perception of singularity must operate against a background of comparability.

The process of qualification also requires that consumers become attached to (and sometimes detached from) the commodities proposed to them (Callon et al., 2002). For example, employees working for genetics trading companies and consumers – in this case farmers – need to be able to understand the genetic value of the bulls whose semen is on sale. Farmers who intend to buy a cow at an auction sale also need to be able to somehow evaluate the cows on sale, and their value. This can be done by simply looking at the cows and thinking that they are beautiful, and simply buying the one that is, for oneself, the most beautiful. But what is beautiful can mean different things for different buyers. It can mean beautiful eyes. It can also mean a frame that promises long lasting milk production. Often the animals are evaluated by looking at breeding values, milk yields or milking speed or by looking at the specific sire of the cows, health issues, and so forth. This information helps to generate the capitalist value of the animals. It also helps to avoid inbreeding. *Somehow*, the animals' value has to be evaluated. In the context of the trade in bovine semen, it literally has to be understood. Employees working for such companies sometimes act as "intermediaries" (Callon et al., 2002). Translating the value of the bulls to farmers, they attach farmers to the commodities by helping them understand the similarities and differences between the bull proofs.

Importantly, markets are always precarious and prone to fail. Callon (1998b, 2007a) uses the term overflowing to address this dimension of marketization. Overflowings are moments of crisis in which framings are disrupted, falter or fail and the instabilities and contradictions that always also

form part of marketization come to the fore. MacKenzie refers to such instances as moments of "counterperformativity" (2007; see also Callon, 2007b). What he means by this is that the practical enactment of economists' market models does not always perform markets – which is to say, help bring them into being and stabilize them – successfully. As Butler highlights (2010), the idea of counterperformativity is a way to explain moments in which the adoption of a market model leads to a situation in which specific market appearances exceed or undermine the model which is supposed to explain and secure them. Butler (2010, p. 150) calls such moments "situations of performative breakdown". As Berndt and Boeckler (2011) further explain, overflows are moments of instability, irritation, or resistance that emerge when heterogeneous actors practically enact markets.

In order for marketization to be 'successful', overflowings have to be veiled. Following Berndt (2015, p. 1868): "'Successful' marketization depends on the ability of its protagonists to veil obvious contradictions and ambivalences, that is, to create an appearance of stability and order of what are in fact processes that cannot be contained in the provided frames". Paradoxically, however, overflowings can nevertheless serve to stabilize. Following Berndt again (2013, p. 2660), "[a]s long as … overflows between inside and outside can be kept largely invisible and their irritating potential be contained, they have a stabilizing effect". Papers I–III all address instances of instability, disruption, contradiction or failure, and their role in stabilization processes.

Central to the relationship between framing and overflowing are processes of inclusion and exclusion. The notion of framing, as we have seen, describes the process by which relations are formed according to market logics. In the process, some relations are included while others are excluded (Callon 1998b, 2007a; Collard, 2014). That is, framing is always incomplete. Yet the excluded relations are never completely abolished. As Callon states in reference to Goffman (1998b, p. 249): "[F]raming puts the outside world in brackets … but does not actually abolish all links with it …. This 'bracketing', which assumes that boundaries are drawn between the actors interacting with one another on the one hand and the rest of the world on the other, does not imply a total absence of relationships". It is these excluded-yet-present relationships that lead commodities to overflow their frames.

To give an example (Paper I): The cows at auction spaces are classified. Classification pacifies cows. It reduces them from "wild unknowns to things with fixed qualities" (Çalışkan & Callon, 2010, p. 6). In the process, the animals are turned into stable objects, made comparable to each other and, hence, tradable. They appear stable on the "milk list" which includes the committees' classification and other information such as the milk yield per day. Yet in the commodification process some relations are excluded. The cows' social relations are not taken into account. Those relations can lead to disruptions. Cows might feel unwell after having been sold and transported

to a new farm because they miss a friend and they might stop eating, which reduces their milk yield, including the milk yield stated on the "milk list" that allowed for trade in the first place. The cows' social relations are always there. But they are excluded in the process that generates stability allowing for trade.

Ultimately, the linked processes of framing and overflowing are the mechanisms which, for Callon, bring markets about. These processes establish and sever ties between the heterogeneous elements that make up the assemblages that are "markets". The combination of framing and overflowing is a "highly selective and exclusionary ordering process" (Berndt & Boeckler, 2009, p. 543).

5. Methodological approach

Methodology aligns "the ontology of a study, how it conceives of the world, with its epistemology, how it claims to know things about the world" (Crang, 2009, p. 457). ANT is based on an ontology that conceives of the world as continuously and relationally enacted into being and that, in so doing, dissolves the binary opposition between humans and nonhumans. A researcher forms part of such enactments and, following Callon's ideas (2007a, 2010), can raise issues that emerge when engaging with multiple others. A researcher therefore is not detached from everything else and rather sees things from somewhere and not nowhere (Crang & Cook, 2007; Haraway, 1988, 1991; Whatmore, 2003a, 2003b). Consequently, this thesis provides a partial, situated and embodied account of the trade in animal genetics and, in so doing, it offers a human account. It does not understand truth as objective, singular and waiting to be discovered because it exists 'out there' (England, 2006). Rather, truth is plural and it exists within what is created.

But how then did I go about, in practice, aligning the study's ontology with its epistemology? And how did I attempt to account for animal presence and agency in the context of the question of animals' commodification?

I used a multi-sited ethnographic approach in order to examine how animals and their live body parts are turned into commodities in the context of the dairy industry. The primary methods used were participant observation and semi-structured interviews. Ethnographies allow for an in-depth engagement with everyday practices and experiences (Herbert, 2000). Conducting fieldwork, I became part of the everyday lives that I wanted to engage with, at least for a little while. Hence, I learned through engagement.

'Classical' ethnographies, however, focus on human practices and experiences (e.g., Crang & Cook, 2007; Herbert, 2000). ANT, as a relational more-than-human ontology, studies everyday practices that involve multiple and heterogeneous bodies, things, tools and knowledges. These practices can also be approached ethnographically (Buller, 2014; Law, 2009; Whatmore, 2003b). Multi-species ethnographic approaches are a way to account for animal presence and agency not only theoretically but also methodologically. Multi-species ethnography is also used in anthropology. It takes into account "[c]reatures previously appearing on the margins of anthropology – as part of the landscape, as food for humans, as symbols – ", pressing them "into the foreground in recent ethnographies" (Kirksey & Helmreich, 2010,

p. 545). Multi-species ethnographers engage with the livelihoods of a multitude of organisms and the question how these livelihoods shape and are shaped by political, economic, and cultural forces (Kirksey & Helmreich, 2010).

Thus, I characterize the methods used in this thesis as 'classical' ethnography with a multi-species twist – an explicit rejection, in practice as well as theory, of what Haraway (2008, p. 11) terms "human exceptionalism": "the premise that humanity alone is not a spatial and temporal web of interspecies dependencies. Thus, to be human is to be on the opposite side of the Great Divide from all the others."

Animals and animal body parts are stabilized as commodities across multiple commercial sites. A multi-sited ethnographic approach implies "some sort of (geographical) spatial de-centredness" (Falzon, 2009, p. 2). The commodification process of cows and bulls and the bovine semen collected from them is de-centred. The commercial sites themselves 'become' in the process. They were selected in the process of conducting fieldwork.

Overview of fieldwork

My thesis builds upon fieldwork mainly conducted in Germany and New Zealand between February 2015 and August 2018. The entire fieldwork phase was guided by the insight that ethnography is about engagement (Crang & Cook, 2007; Herbert, 2000). My PhD project started in September 2014. Two pilot studies were conducted in Sweden and in Germany between February 2015 and January 2016. They preceded the subsequent fieldwork phases conducted in Germany. These included multiple trips between January 2016 and August 2018 encompassing different seasons. The fieldwork conducted in Germany between January and February 2016 involved a shift in focus which also ended the pilot study phase. During my pilot study I broadly engaged with the dairy sector. From mid-January onwards fieldwork concentrated on auction sales and on interviewing dairy farmers, at first with a primary interest in robotic milking (see below). I therefore consider the thesis' main fieldwork phase from mid-January 2016 to August 2018.

Fieldwork in New Zealand comprised several fieldwork trips on both the North Island and the South Island. During my 6-months visit, from March to September 2017, I was based in Auckland. Hence fieldwork was conducted during the New Zealand autumn and winter months. Farmers select bulls for AI during these months. The primary calving season is in wintertime. The majority of farms follow a seasonal calving scheme which includes one primary calving season. Shortly after that period the cows are inseminated again. In Europe cows are usually inseminated all year round. They therefore also calf and produce milk all year round. In New Zealand cows are usually all inseminated at the same time. They therefore also calf, more or less, all at

the same time once per year. The calving season varies to some extent between the North Island and the South Island due to different climatic conditions.

I also conducted fieldwork in Switzerland in July 2018. This fieldwork comprised one semi-structured interview with a researcher whose work focuses on cattle breeding in especially organic agriculture. Interviewing an expert provided additional insights on different approaches to breeding and on breeding value calculation. I also conducted additional fieldwork in Sweden in November 2017 and May 2018. I attended a university lecture held by an employee working for a bull semen collection facility in the United States, and I interviewed another researcher working in the field of breeding value calculation in an international context. This fieldwork focused on the global trade in bovine semen.

In total 71 semi-structured (formal) interviews were conducted. Additionally, fieldwork included participant observation at 22 different research sites comprising a total number of 36 visits (informal interviews were not counted) (see Table 1, 2 and 3 for a list of all fieldwork activities). Textual and visual material was collected in connection with those visits and with the semi-structured interviews. The interviews were either conducted on-site (e.g. during auction days) or at the interviewees' ordinary workplace (e.g. genetics trading companies). [1]

Fieldwork also included desktop research. The focus was on collecting additional information on breeding value calculation, on the organizational structure of the cattle breeding sector and the trade in bovine genetics, and on biosecurity regulations published on governmental homepages. Fieldwork also included online research and archival research into the auction spaces visited. This material informs my understanding. The material collected on Germany's and New Zealand's biosecurity regulations was analysed in connection to the semi-structured interviews conducted with employees working for companies trading genetics, in which the employees referred to specific standards and regulations. These standards and regulations shape their everyday work.

[1] I use the term 'collect' here and in the subsequent sections. Yet I follow Whatmore's idea of "generating materials" (2003b, p. 90). I see the research process as an active, mutual process. The notion of "generating materials", following Whatmore, "suggests that data, like questions, are produced, not found, and that the activity of producing them is not all vested in the researcher."

Table 1. Fieldwork activities pilot study, Sweden and Germany (2015-2016)[2]

Sweden	**Method**
Interviewing employees working for a manufacturer of milking robots	1 interview (2 interviewees)
Interviewing farmers	3 interviews (2 of the 3 farmers interviewed were dairy farmers using milking robots)
In total:	4 formal interviews
Germany	
Attending a trade fair (focus on organic food)	2 visits (2015 and 2016), participant observation
Interviewing consultants working for an organic association	2 interviews (focus on robotic milking)
Attending an information meeting for farmers on robotic milking (organic sector)	Participant observation
Interviewing dairy farmers (focus on milking systems)	2 interviews (1 farmer used robotic milking)
Accompanying a veteriarian at work	2 visits, participant observation and informal interviews during daily farm tour
Interviewing a herdswoman (female stockman)	1 informal interview
Accompanying a milking truck driver	Participant observation and informal interview
Interviewing employees working for 2 local dairies	2 interviews (1 interview included two employees, dairies different in size)
Interviewing the principle of an agricultural school	1 interview
Attending a milking course held at an agricultural school (1 week)	*Participant observation*
Interviewing the director of a district's federal state institution for cattle breeding	*1 interview*
Attending a cattle auction	*1 visit, participant observation (accompanying the director of the district's federal state institution for cattle breeding to the auction space after the interview)*
In total:	8 formal and 4 informal interviews, 8 visits at 6 different sites using participant observation as a method
Additional activities in Sweden	
One interview with a dairy farmer was planned but did not take place due to logistical problems.	
Additional activities in Germany	
Visiting neighbours and friends who run dairy farms/ keep cows for subsistance agriculture (asking questions about and participating in farming)	

[2] The activities marked in italic are those that subsequent fieldwork activities built upon. Yet all activities inform my understanding of the dairy sector and hence of the trade in bovine genetics.

Table 2. Fieldwork activities, Germany and New Zealand (2016-2018)[3]

Germany	**Method**
Attending cattle auctions	14 visits at 2 different auction spaces, participant observation and informal interviews, collecting textual and visual material, online research and archival research, observation of animals
Attending the auction sale of calves organised by the same breeding society and held at one of the auction spaces (calves used for fattening)	1 visit, participant observation
Attending the sale of calves organised by the same breeding society and held at one of the auction spaces (calves used for fattening)	1 visit, participant observation
Attending a cattle auction at a different, third auction space located in a different federal state and organised by a different breeding society	1 visit, participant observation and informal interviews, collecting textual and visual material
Interviewing the auctioneer working at the 2 auction spaces frequently visited	2 interviews
Interviewing a veterinarian working for a district's federal state veterinary institution	1 interview
Interviewing a veterinarian working for a non-governmental institution concerned with animal health issues	1 interview
Interviewing dairy farmers	16 interviews (including 1 follow-up interview, some interviews involved more than 1 family member)
Doing farm work at 2 different dairy farms (for 1 week each)	Participant observation and informal interviews, visiting both farms several weeks after my stay and conducting 1 formal interview with 1 of the farmers (see follow-up interview mentioned above)
Interviewing employees working for a breeding society	3 interviews with 2 employees working for the society and with the president of the society
Interviewing employees working for a district's federal state institution for cattle breeding	5 interviews (including 3 follow-up interviews, 1 interview was conducted on the phone)
Interviewing an employee working for a federal state governmental institution on cattle breeding (focus on breeding value calculation)	1 interview
Attending trade fairs	Visits at 3 different trade fairs (1-3 day visits), participant observation and informal interviews, collecting textual and visual material

[3] Sometimes employees working for the different German institutions are involved in the auction sale of breeding stock and in the trade in bovine semen. Sometimes fieldwork activities therefore covered both themes.

Interviewing employees working for bovine genetics trading companies/collection facilities	7 interviews with employees working for 3 different companies (5 interviews were conducted with employees working for 1 of the 3 companies), participant observation at 1 of the 3 companies (1 week)
Interviewing a consultant who formerly worked for an organic association (focus on cattle breeding)	1 interview
Additional activities	
Interviewing a herdsman (stockman)	1 interview (additional information on farming structures, auction sales and AI)
In total:	38 formal interviews (including follow-up interviews), 23 visits at 11 different sites using participant observation as a method
New Zealand	
Attending trade fairs	Visits at 4 different agricultural events (3 trade fairs and 1 agricultural show), participant observation and informal interviews, collecting textual and visual material
Interviewing employees working for companies trading bovine genetics (focus on importing genetics from overseas)	6 interviews with employees working for 5 different companies (1 interview involved 2 employees; 1 interview was conducted during sales tour)
Interviewing farmers	12 interviews (11 interviews were conducted with dairy farmers and 1 interview was conducted with a beef breeder who imports bovine genetics from Germany and other countries, 5 interviews involved 2 family members)
Interviewing an employee working for an 'industry-good' organisation responsible for breeding value calculation	1 interview
In total:	19 formal interviews, participant observation at 4 different sites

Table 3. Additional fieldwork activities, Sweden and Switzerland (2017-2018)

Sweden	
Interviewing a researcher working on breeding value calculation (international context)	1 interview
Attending a university lecture held by an employee working for a collection facility in the US	1 visit, participant observation
Switzerland	
Interviewing a researcher working on cattle breeding (organic sector)	1 interview
In total:	2 formal interviews, participant observation at 1 site

Cases studied

I was based at Uppsala University in Sweden and had little-to-no previous knowledge of (dairy) farming. I therefore started engaging with dairy farmers in Sweden who were running farms close-by in spring 2015. I used personal contacts to get in touch with the farmers. I also contacted the Federation of Swedish Farmers (in Swedish: Landbrukarnas Riksförbund (LRF)) and I searched online for a specific farm-related event (in Swedish the event is called 'kosläpp'). Initially, I was interested in robotic milking and the human-animal-technology relations involved in this comparatively new milking system. Two of the three Swedish farmers visited used milking robots. I also interviewed employees working for a Swedish manufacturer of milking robots. The interviews were conducted in Swedish. In parallel, starting in February 2015, I conducted fieldwork in my home region in Germany, which is a dairy region. I, again, broadly engaged with the dairy sector, with a particular interest in robotic milking. But I also visited an auction space.

This first visit in July 2015 and further visits in January and February 2016 shaped my entire PhD project. They led me to write about the trade in bovine genetics instead of milking robots. They led me to become interested in the trade in breeding stock and in the global trade in bovine semen – which led me to choose New Zealand as a second case study. The names of the sires of the cows on sale were repeatedly mentioned by the breeding director and the auctioneer (see introductory chapter). Their names also appeared in the auction catalogue, and I started to wonder who and where those bulls were who were present at the sales and yet not physically present.

Finally, I chose Germany as a case study for three main reasons: i) When I started my project in September 2014, my home region had a comparatively high number of milking robots. This primarily explains the choice made in the beginning to focus on Germany. Milking robots are especially popular in Western and Northern European countries. Their popularity is linked to comparatively high labour costs and small herd sizes (Beekman & Bodde, 2015; Holloway, Bear, & Wilkinson, 2014). One milking robot is said to be able to milk between 70-80 cows. Moreover, my family has a dairy farming background and I wanted to know more about the region's dairy sector. I was especially interested in the changes that were happening in relation to dairy farming. I had observed that green grass was turned into maize fields, and that the coat colour of the animals grazing outside on the fields in summertime had changed. (Farmers kept different breeds and there were more cross-bred animals on the fields than there used to be). I was also fascinated by my grandfather's enthusiastic disbelief when a friend of his told him about his son's milking robots at a local event held at our village. Sitting next to them, I was fascinated, too, and I wanted to know more about robotic milking.

ii) In the course of my pilot studies I found that it was much easier to gain access to the field in Germany than it was in Sweden. I had grown up in Germany and simply knew of certain institutions that would be relevant to contact. I also had more personal contacts that I could use to establish contacts in the field. It was also easier to logistically organise fieldwork trips. As I had little knowledge of the dairy sector, I decided to try and spend less time on the organisational aspects of fieldwork – such as finding accommodation and getting to know the area, which I would have had to do in Sweden – and to focus more on the workings of the sector itself, which was easier to do in Germany.

iii) Germany is the EU's largest milk producer, it has the highest number of cows in the European Union and both live animals and bovine semen are traded within and across borders. Moreover, Germany is an EU member state. Regulations on trade and biosecurity apply for Germany but also for other EU member states. Engaging with Germany as a case study allowed me to address national, EU-wide and international trade in bovine genetics.

My research focused on one particular German federal state. Cattle breeding is organised differently in different German federal states. This includes breeding value calculation, which also differs between breeds. Cattle breeds, in turn, are present to different degrees in different federal states and breeding values are calculated by institutions located in areas where those breeds are present. Moreover, and linked to the organisational (institutional) structure of the cattle breeding sector, the trade in bovine genetics is organised differently. Both sectors are interlinked but, again, to different degrees in different federal states. Governmental veterinary agencies are partly also organized differently. Those agencies are responsible for ensuring that biosecurity legislations are followed. In order to gain an understanding of the workings of the sector I chose this one federal state as an example. I also primarily engaged with one particular administrative district. I engaged with mainly two dairy cattle breeds. Both breeds are primarily present in this particular federal state.[4]

Concerning the auction spaces visited, fieldwork was conducted at two different sites. They are located 60km from each other within the same administrative district. The auction sales are organised by the same breeding society. Hence, they are organised in similar ways. It is mainly one dairy cattle breed that is traded. The auction spaces in question constitute the primary location for the auction sale of this breed.

I chose New Zealand as a case study for two main reasons: i) When I started my PhD project, the German media repeatedly reported about New

[4] The name of the federal state is not mentioned in order to protect the research participants' identity. In the papers I used pseudonyms and I left out other information in order to make an individual less recognizable. This also includes the specific cattle breeds I looked at. The animals' names have partly also been changed.

Zealand – "the world's most important exporter of milk" (Winzer, 2014) – in the context of the decrease in milk prices for conventional cow's milk in Germany and the EU. The years 2015 and 2016 are often referred to as the years of the milk crisis. I had always associated New Zealand more with sheep and less with dairy cows. I had never been to New Zealand prior to my fieldwork trip. With the country being present in the German media in relation to dairy farming and cow's milk, I became interested. In short, I chose New Zealand because it is a dairy country.

ii) Simultaneously, I started to ask my German research participants about New Zealand, and I was surprised about their replies. New Zealand was often depicted as 'different' and 'not comparable' to Germany or other European countries or European conditions, including in connection to breeding value calculation. But what exactly was so 'different' about New Zealand? And why and how is bull semen traded across such a large physical distance? A German dairy bull has family in New Zealand? Initially, I was interested in the trade relations between Germany and New Zealand. But I widened the scope of the study after the first field visits in New Zealand, as bovine semen collected from AI bulls located in various Global North countries is imported to New Zealand.

My research focused on the Global North for three main reasons. i) Breeding value calculation is a Global North phenomenon. Data has to be collected, processed, stored and continuously made available which demands financial resources. This is one reason why breeding values are primarily calculated in and by Global North countries. ii) Global North countries also keep similar cattle breeds. This partly has to do with similar climatic conditions. The fact that Global North countries calculate breeding values and keep similar cattle breeds is important because when those countries start trading with each other, breeding values derived from different statistical calculations start interacting with each other and have to be negotiated in order to allow for trade because they differ (see Paper II). iii) Moreover, the number of artificial inseminations is comparatively high. As mentioned earlier, in Europe around 90 percent of all cows are artificially inseminated. The practice of AI is in general more common in the dairy than in the beef industry, partly because husbandry conditions differ. Semen collected from beef bulls is also used in order to artificially inseminate dairy cows. The auction spaces visited in Germany hold an EU approval which allows for trade within Germany and the EU.

Selecting participants and research sites

Primarily personal contacts were used in order to access field sites and participants (Crang & Cook, 2007). I also searched online for institutions and companies involved in dairy farming and related sectors. I either knew of

them or I had read about them in the local newspaper and by searching the web. I also participated in a milking course held at an agricultural school, which helped me to meet farmers and gate keepers (the principal of the school). I also used snowball sampling (Crang & Cook, 2007). I asked participants to name a person they thought would be interesting for me to talk to. I also approached participants directly asking for contacts. Whenever participants did not immediately name a person, I used selection criteria to specify 'interesting'. This specification revolved around the person's profession. I hence selected participants according to "the quality and positionality of the information" (Crang & Cook, 2007, p. 14).

The German dairy farmers were selected on the basis of the following main selection criteria; i) milking system; ii) cattle breed. I also aimed for diversity in this sample in order to find out about differences in regard to milking systems and later, as the focus shifted, in regard to cattle breeds. The sample included organic and conventional farms. I interviewed farmers who used semen in order to AI their cows, and who had bulls on their farm. I also interviewed farmers who sold animals at the auction spaces visited, and those who did not. All interviews (except for my very first interview) were conducted in the cow shed or while walking around on the farm. Some interviews were conducted both outside and inside the farmhouse. These interviews and farm visits also helped me to develop an understanding for dairy farming.

The farmers whom I interviewed, whom I talked to at other occasions, and whom I heard about through others working in the dairy sector, buy bovine semen from primarily two different bull semen collection facilities. These facilities sell semen from their bulls and from other organisations. I conducted in-depth research at one of the two facilities, in the form of participant observation (1 week) and semi-structured interviews with the staff. I had visited the centre before, conducting one interview with an employee. The centre does not organise the export itself. But I interviewed an employee working for the company that organises the export for that centre. This company does not run its own breeding centre. It organises the export for several breeding centres (including the one I visited). It also exports to New Zealand. I also interviewed an employee working for another centre. The centre organises the export of bovine semen itself. This company, too, exports to New Zealand.

I also asked interviewees for upcoming agricultural events and I searched online which helped to identify future research sites, especially in regard to trade fairs. I approached individuals at the various events. In so doing, I established further contacts. Employees working for the different trading companies are present at these trade fairs. Visiting these fairs enabled me to approach them directly. Hence, the trade fairs were research sites. But they were also important places that helped me to access the field and to establish

contacts. Following this selection strategy allowed me to finally arrive at a point of "theoretical saturation" (Crang & Cook, 2007, p. 14).

I gained access to the New Zealand dairy sector by attending a trade fair in the very beginning of my 6-month stay. I had searched online for upcoming events. I had also visited a trade fair in Germany before travelling to New Zealand. New Zealand-based companies were present at the fair. Using the exhibition catalogue, I visited them at their fair stand. I also approached employees working for German companies at this fair and I asked for information on and contacts in New Zealand. At the fair I also received information on a specific breeding society. The majority of dairy farmers interviewed in New Zealand are members of this society.

Hence, I selected participants according to the quality and the positionality of the information. I also aimed at including most of the active members of the breeding society. It is a minor society but its members live in different parts of New Zealand which made it impossible to interview all of them. I aimed for and I finally also included all companies importing bovine semen from overseas. I also attended agricultural events that were happening during my 6-month stay. Three of the four events visited were trade fairs/sales events. One was an agricultural show. Nineteen semi-structured interviews were conducted in total. Ten of these interviews were conducted with individuals who originally came from European countries, the US, Australia and South Africa. Except for one individual all interviewees in Germany were German.

Methods

The main methods used were *participant observation* and *semi-structured interviews*. Participant observation included taking notes and conducting informal interviews. Informal interviews were often not tape-recorded. Notes were taken instead. The *fieldnotes* were typewritten in order to guarantee legibility. They were partly written on the textual material itself, for example, on the "milk list" during auction sales. In my analysis I used both the handwritten and the typewritten fieldnotes. In combination with the textual material collected, the notes allowed for a deeper understanding of the commodification process. The *textual material* included, above all, auction catalogues and "milk lists" as well as breeding catalogues and other sales and advertising material such as flyers which were collected at trade fairs and when visiting trading companies. I also collected *visual material*.

In connection to the auction sale of cows, I took pictures of the buildings and of the various steps of the auction sale (after having asked for permission). The pictures were used in order to develop an understanding of the various steps involved. Many activities happen on auction days and they partly happen at the same time. The pictures helped to recall these sales and

to structure my thoughts and impressions. They also provided an additional entry point; they helped to grasp the atmosphere 'in a different light'. They also made me 'see' things. They made me 'see' the animals in relation to the textual material collected. The textual material describes the animals in a specific way. The pictures also describe them, but in a different way. In so doing, they shaped my understanding of the relations between animal and commodity. I also took pictures of, for example, the company's depots (after having asked for permission). This material was mainly collected in order to develop an understanding of the trade in bovine semen. I did not analyse the pictures per se.

Participant observation at the auction spaces visited also included the *observation of animals*. I took notes on what I saw and how I, myself, understood the animals' actions and behaviour. In so doing, I followed Lydia Davies' example. In her book "The Cows", Davies (2011) writes about the cows she lives close-by to. Her writings include her own perceptions and interpretations of what the cows (possibly) do. Similar to the pictures that I took, the practice of observing animals itself and my notes shaped my understanding of the relations between animal and commodity. Engaging with the cows, I also paid attention to their *moo*.

The *semi-structured interviews* were conducted in German and in English. All interviews were transcribed. Additionally, I took notes on the interviewees' gestures and other activities, for example, when they marked things in the breeding catalogues lying in front of us. I then compared the interview transcripts with my additional notes which enhanced my understanding of the spoken word and my understanding of the interview situation in general. Additionally, I took notes describing the rooms, the buildings and the areas where the interviews took place, which enhanced my understanding of the particular research sites. As mentioned earlier, I also conducted *online research* on mainly governmental homepages. Fieldwork also included *online research* and *archival research* into the auction spaces visited.

In Paper I, the role of the cows at the auction space is approached through human perceptions, understandings and expectations of what they do and especially of what they should and should not do. In Papers II and III, we learn about the bulls whose semen is collected, traded and used to artificially inseminate dairy cows – precisely by not learning about them. For the process that stabilizes bovine semen as a commodity is a process that limits the agency of bulls and obscures their presence. Papers II and III thus approach bulls as pacified. Paper I addresses pacification processes and unpacified cows. The trade in bovine semen works not only on the basis of abstraction (Paper II). It also works on the basis of a physical distance that is created between bodies and body parts (Paper III). This distance involves technical-mechanical steps (the process of producing semen straws). It also involves biosecurity procedures. Only certain staff have corporeal contact with the animals. This also creates certain limitations in how AI bulls can be ap-

proached method-wise. AI bulls can also be dead, but the semen collected from them is still being traded (see also Colombino & Giaccaria, 2016). The trade in bovine semen works, as mentioned above, on the basis of a bodily distance or absence of the bulls. This absence can also involve the death of the bulls.

Analysis of material

Data analysis, Crang and Cook (2007, pp. 132-133) emphasize, does not involve some kind of 'raw' data. Data has "already been partly analysed, made sense of, [and] ordered in the research process". Research questions have been focused and re-focused; and in terms of interviewees, specific individuals have been chosen and involved in the project. Following Crang and Cook further, the formal stage of analysis entails much more careful and critical consideration of the material. It is designed to enable the researcher to see new themes and patterns.

I started the formal process of analysis by listening to and transcribing the semi-structured (formal) interviews and by reading through the transcripts, partly while listening to the tapes. I also carefully read through my fieldnotes and the other textual materials collected. This meant that I sometimes simply sat on the floor, surrounded by breeding catalogues, looking at bull proofs. I engaged with my material in this way several times and at different stages of the project. I took notes, partly on separate sheets of paper, when I noted particularities. This process was rather open, and it can be described as a form of "open coding" (Crang & Cook, 2007, p. 137). The material collected included different types of textual material; interview transcripts, fieldnotes, auction catalogues, "milk lists", breeding catalogues, and flyers. The process of analysis therefore also included cross-reading materials. In parallel, I looked at the pictures that I had taken at the various research sites. I also drew maps in order to structure all the information concerning the organizational structure of the cattle breeding and the genetics trading sector. And I started to identify the different steps involved in the auction sale of breeding stock.

I then started to identify themes, correspondences, differences and other relationalities. The question of how animals are stabilized as commodities was re-focused in the course of the project. The process of analysis was conducted in constant conversation with the literature (see Whatmore, 2003a). The writing process was also important. "Throughout the research process", as Crang and Cook (2007, pp. 132-133) highlight, "writing and analysis are inseparable". In short, my project did not follow a linear first "read-*then*-do-*then*-write model" (Crang & Cook, 2007, p. 17, emphasis in original).

Early on, my project was informed by the idea that economies are enacted by both humans and nonhumans. My visits to the auction space demonstrat-

ed that animals are active; that they shape the auction sale. But these visits also revealed the limitations of their influence. Simultaneously, they showed that multiple efforts are needed in order to allow for the exchange of cattle. The classification process included multiple such efforts; and it helped establish the value of the animals on sale. After further consideration, the concept of marketization was identified as helpful to address these efforts as well as the role of the animals themselves in the process (Paper I).

In the context of the trade in bovine semen (Paper II-III), I focused on breeding value calculation and on the role of biosecurity. The former was identified as a significant phenomenon in the course of 'making sense while going about' and during the initial stages of analysis. The latter emerged as a significant theme somewhat later, during the formal stages of analysis. The analysis made me better 'see' the role of biosecurity in the commodification of bovine semen. Biosecurity had been mentioned by five research participants in Germany in connection to both the auction sale of breeding stock and the trade in bovine semen. It materialized as a significant dimension of my findings from the fieldwork conducted at the breeding centre in Germany. Moreover, it (re-)emerged in nine of the twelve interviews conducted with farmers in New Zealand, and in four of the six interviews conducted with employees working for the different genetics trading companies. And it formed part of the lecture held at a Swedish university by an employee working for a collection facility in the US. In regard to the studies presented in Papers II-III, marketization was deemed a powerful conceptual lens for similar reasons to the ones described above in relation to Paper I.

6. Paper summaries

Paper I

Stabilized instabilities: on the unruly nature of a "lively commodity"

This paper addresses dairy cows as nonhuman "lively commodities" (Collard & Dempsey, 2013). Examining the trade in breeding stock at auction sales, it focuses on how cows exceed market logics because they are sentient living beings who sometimes (obviously) do not act according to market logics. Addressing the commodification process of this particular nonhuman lively commodity, the paper studies the ways in which the cows' unruliness challenges commodification, or commodity "stabilization". It draws upon ethnographic and interview-based fieldwork conducted at cattle auctions in Germany.

All cows are classified at the auctions visited. Classification is what Michel Callon (1998b, 2007a, 2007b, 2010) refers to as a commodity stabilization – a "framing" – process. In the process the cows are made comparable to each other and, hence, tradable. Following Callon, markets and, thus, commodities are always needing to be stabilized in order to exist. Importantly, the process of stabilization – of framing – always also involves "overflowing". Overflowings are moments of instability, disruption and contradiction in which markets are not enacted accordingly to market logics (Berndt & Boeckler, 2011; Berndt 2015; Ouma, 2015). The paper approaches cows at the auction space drawing upon the idea of framing and overflowing, and the concepts of "fictitious commodities" and "counter-movement" developed by Karl Polanyi (2001[1944]). Cows are fictitious commodities because it is 'life itself', the animals' life, that is commodified.

Revealing how animals 'become unruly' in the process of marketization itself, the paper shows how unruly instabilities are created, and how they are continuously veiled. It argues that the process of 'becoming unruly' unfolds in a double process of producing and veiling nature's unruliness to commodification, allowing markets to work on the basis of a status of stabilized instabilities. But do the cows really act unruly at all? Interrogating the idea of nature's unruliness, the paper suggests that we might be distracted from our own distraction from 'life itself'. It seeks to contribute to the geographical literatures on marketization and on the commodification of nature.

Paper II

Trade-a-bull: the struggle over commensurability, and the satire of economic reason

This paper addresses the paradoxical nature of capitalist markets, especially the idea that commodities emerge from an oscillation between comparability and difference. It studies the construction and negotiation of this market paradox in the context of transnational markets in bovine semen and with a particular focus on the dairy industry. Using breeding value calculation as an example, the paper focuses on measurement and abstraction in the commodification of this particular nonhuman "lively commodity" (Collard & Dempsey, 2013). It draws upon multi-sited ethnographic and interview-based fieldwork mainly conducted in Germany and New Zealand.

Breeding values – statistical estimates of the genetic 'value' of animals – are used in order to select bulls whose semen is used in order to artificially inseminate cows. Breeding values make the bulls comparable – commensurable. But there is often no consensus on how to measure genetic 'value' in order to select for the 'best' animals. Breeding values therefore are often not comparable across countries. Following Michel Callon and collaborators (2002), commodities have to be constructed according to the 'similar yet different' principle in order to allow for comparability and, hence, for selection. They have to be distinct vis-à-vis comparable commodities. But in transnational markets in bovine genetics, this principle is threatened.

Addressing multiple such "singularization" processes, the paper demonstrates how commodities emerge in an oscillation between comparability and difference, making simplification become complexity. This process, which I refer to as the struggle over commensurability, appears absurd at times. The paper discusses the seeming absurdity of markets in reference to David Harvey's reflections in his book "Marx, capital and the madness of economic reason" (2017). Following Harvey (2017, p. 173), one aspect which constitutes the absurdity or madness of markets is the "perpetual pursuit of an 'incompleteable infinitude' on the part of capital". Discussing the iterative character of singularization, the paper argues that the "marketization" of animals' genetics has no absolute 'limits'. Rather, relative 'limits' to exchange are created in order to be overcome.

This seeming boundlessness, however, is only made possible on the basis of our consent to markets and their rules. Interrogating this consent, the paper reveals the 'satire of economic reason'. It seeks to make a contribution to the geographical literatures on marketization and on the commodification of nature.

Paper III

Securing value flows: biosecurity and the global circuits of a "lively commodity"

This paper is concerned with the entanglement of biosecurity and capitalism. Addressing the international trade in bovine semen used in the dairy industry in order to artificially inseminate cows, it looks especially at the role of country-specific differences in biosecurity procedures, and how those shape the commodity circuits of this particular "lively commodity" (Collard & Dempsey, 2013). The capitalist value of bovine semen is derived from it promising future life for generations of cattle. But, as a living organism, it is also always a potential host body for bacteria and viruses that can spread when it is traded. It therefore has to be "made" biologically secure in order to allow for trade and, hence, for value exchange.

The 2020 corona crisis has made visible the consequences of country-specific differences in biosecurity practices on human travelling patterns. Humans serve as host bodies for this specific virus and they can, consequently, carry and spread the virus. As a potential host body for multiple bacteria and viruses, the commodity circuits of bovine semen likewise are significantly shaped by country-specific differences in biosecurity practices, but they are never frozen completely.

Informed by the work by Michel Callon on "marketization" (1998a, 1998b, 2007a, 2007b; Callon et al., 2002; Çalişkan & Callon, 2009, 2010), the paper examines the entanglement of biosecurity and capitalism focusing on the role of biosecurity standards in the commodification (or commodity "stabilization") process of bovine semen. Drawing upon multi-sited fieldwork mainly conducted in Germany and New Zealand, the paper shows how the circulation of capitalist value in markets in bovine genetics is enabled in spite of international incommensurability in bio-securitization processes. This continuous circulation is made possible, the paper argues, because both value and biosecurity are relational. This relationality involves our relationship to other animals and other natures in general.

Discussing the fact that biosecurity practices are implemented in order to make animals and their live body parts secure and, hence, tradable across the globe, it seeks to make a contribution to the geographical literatures on "marketization" and on biosecurity. Both literatures engage with relational ordering processes, but without a specific focus on the role of the relationship between humans and animals and indeed other 'natures' more generally.

7. Conclusions

The principal aim of this thesis was to study the workings of capitalist markets in order to advance our understandings of these crucial phenomena. This has been done in the context of the global markets in dairy genetics and with a particular focus on the Global North. Informed by the work by economic sociologist and actor network theorist Michel Callon, the thesis used a performative approach to study the workings of markets and especially the commodification of animals and their live body parts. The thesis was primarily concerned with valuation and bio-securitization processes and the role of the animals themselves in the commodification process. Offering a geographical approach to marketization, it attended to the spatialities involved in the marketization of animals by, for example, looking at the role of international incommensurability and associated 'bordering' in valuation processes. Informed by the work by Rosemary Collard and Jessica Dempsey on nonhuman lively commodities, it approached the human/animal divide as made and as allowing for the commodification of animals. Focusing on the continuous circulation of capitalist value in markets in dairy genetics, it addressed the "making" rather than the "unmaking" of this divide. The thesis' key findings, arguments and contributions are outlined below.

Studying the workings of markets informed by a technical inflected approach to performativity and with a primary focus on valuation and bio-securitization processes and the role of the animals themselves in the commodification process, the thesis showed how various types of distinctions are created in the marketization of dairy genetics, and it demonstrated how these distinctions allow for trade also in spite of the potential limitations that are, likewise, created in the process. Paper I engaged with the distinction created between animal and commodity and, in so doing, it addressed the production of differences among the animals on sale. Animals are always distinct. They are individuals. But the process of commodification creates a specific form of distinction; a distinction according to economic parameters which allow for trade. Paper I also looked at the distinction created between the ideal cow and the unruly cow and its role in the marketization process. Paper II examined differences created between the genetic value of AI bulls, and Paper III engaged with the production of distinctions in regard to how the bovine semen collected from AI bulls becomes biologically secure or risky in different geographical contexts. Addressing those distinctions and their role in the marketization process of dairy genetics, all three studies also engaged with

the human/animal divide; the distinction between those that are capable of valuing and those that are being valued. In connection to Paper III, this distinction also forms part of the need for a physical, bodily distance that allows for trade.

Papers I and II furthermore addressed mechanisms of distraction that allow for the workings of markets in dairy genetics. In suggesting that marketization distracts us from our own distraction from 'life itself', Paper I looked into the role of distraction by interrogating the idea of nature's unruliness towards commodification. Paper II looked into the role of distraction seeking to remind us of our taken-for-granted understandings and even more so of our consent to markets and their rules, which are always also needed in order to allow for the workings of markets (Berndt & Boeckler, 2011; Robertson, 2012b).

Previous studies have certainly addressed the production of distinctions (or differences) and their role in the workings of markets (e.g., Berndt & Boeckler, 2011; Berndt, 2013; Collard & Dempsey, 2013; Collard, 2014; Hébert, 2010; Ouma, 2010; 2015; Robertson 2006, 2012b; Pütz, 2019). In so doing, scholars have also engaged with the role of taken-for-granted understandings (see chapter three and four and Paper II for an elaboration of this point). But those studies tend to focus on one of the aforementioned forms of distinction created between 'things'. Studies informed by the work by Callon and other economic sociologists tend to focus on valuation processes and, in so doing, on the role of qualities created in the marketization process (e.g., Ouma, 2010; Pütz, 2019). The Marxist inspired political economies of nature literature addresses the relation between humans and the natural world as decisive for the workings of capitalism (e.g., Robertson & Wainwright, 2013). But there is a tendency to leave the semiotic processes aside (see also Bigger & Robertson, 2017; see the work by Robertson for an exception). The work by Collard and Dempsey, on the other hand, engages primarily with the making and unmaking of the human/animal divide in the market context.

This thesis offers a combined approach. Using this approach, it suggests that markets operate on the basis of various forms of distinction created in the process of trading itself, and, simultaneously, via mechanisms that distract us from the very distinctions created. In connection to this argument I propose that it might be worthwhile for future research to look in more detail into the type of distinctive market mechanisms that we might be distracted from, in other words, those we take for granted and consent to.

Selective breeding is about the production of differences. Differences are needed. They allow actors to select animals – the 'best' ones (Holloway et al., 2011; Parry, 2015). What is considered as 'best' might vary and, as the thesis showed (Paper II), it varies contextually. But it is characterized by economic concerns. Thus the question of how selection is enabled and with what aim is not only a theoretical concern. Market performances have con-

sequences. They change realities. Selective breeding is all about change. Certain traits are selected precisely in order to effect transformation. In examining how selection is enabled and with what aim, this thesis complements the work of Holloway and colleagues (e.g., Holloway & Morris, 2008, 2012, 2014; Holloway et al., 2011; Morris & Holloway, 2009) and others (e.g. Lonkila, 2017) who have engaged with animal breeding and breeding value calculation. Its specific contribution consists in its specific focus on the workings of markets and, in so doing, in how breeding values are calculated in an international context and how the distinctions created allow for the continuous circulation of live animal body parts.

I acknowledge, as mentioned (Paper II), the potential benefits of breeding values calculated for traits that might make the act of calving easier for the cows. Or the benefits of values calculated for health traits such as somatic cell count. Or the benefits of values calculated for the trait milk yield, because it also enables the selection of bulls with a higher probability of inheriting a lower milk yield. But there is a risk that such distinctions distract from the very fact that such values *are* calculated. There are also recent trends, such as the use of sexing technologies to pre-select the sex of calves, that point to a deepening of the commodification of 'life itself'; to a more intense exposure of 'life itself' to economic calculus (Collard & Dempsey, 2013; Cooper, 2008). The introduction of technologies that allow for selecting the 'best' animals in a shorter period of time points in a similar direction. Such developments carry the risk of seeing 'life itself' simply as a commodity. I therefore conclude with Robertson's words, in paraphrased form, in mind (2012a, p. 389): buying bovine genetics is one thing; the creation of a world in which 'life itself' already is legible as a commodity is another. The thesis reveals mechanisms that help to create such orders. But it emphasizes that such orders *are* always created.

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