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Sub-theme 51: Valuation and Evaluation within and across Organizations.

The role of evaluation devices in the creation of new institutions: breeding contracts under the “genomic” era in animal genetics

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The role of evaluation devices in the creation of new institutions: breeding contracts under the “genomic” era in animal genetics

INTRODUCTION

Since the modernization of agriculture, the market for animal genetics represents significant financial flows between countries and constitutes the core economic activity for hundreds of companies (from small breeders associations to large biotech companies), selling frozen semen and embryos worldwide. This market is a privileged object of analysis of valuation practices and processes for two reasons: one related to devices, the other to the social context.

First, the value of animals on this market can be assessed through several devices and knowledge systems, from “traditional visual and experiential knowledge”, aesthetic knowledge and animal shows to statistical genetic models, “scientific knowledge” and national system of evaluation through progeny testing and “genetic indices”. In France, national R&D institutes have been responsible since 1966 for the genetic evaluation of animals (INRA, Institut de l’Élevage) and for ensuring objectivity and efficiency in the calculation processes by means of a national database on animal performances. If some authors (Holloway *et al.* 2011) tend to oppose these two systems of valuation (valuation by farmers’ visual expertise and valuation by genetic models), we have shown that they are deeply intertwined (Labatut *et al.* 2011; Labatut *et al.* 2012). This diversity of evaluation practices and knowledge make this market a great topic of study in the area of valuation.

Second, the market for animal genetics has recently been subject to two major societal changes. The first change is the liberalisation of the object of evaluation and commoditization (the semen market) and of the service of evaluation itself. In France, the market for animal genetics has been open to competition between breeding companies since 2006, and the market for evaluation services will be opened in 2016. The second change is the implementation of a new evaluation system: genomic evaluations. The previous system of scientific evaluation (progeny-testing), which is based on quantitative genetics, required 4 to 5 years to evaluate the genetic potential of a bull before its semen could be sold. The genomic system, developed through innovations in bioinformatics and DNA sequencing, allows for an instantaneous evaluation of the genetic potential of an animal (a male, a female or even an embryo), using DNA chips. The market for animal genetics is thus facing simultaneous institutional and political change that, combined with a technical breakthrough in its

evaluation system, presents a stimulating opportunity to better understand the relations between evaluation, valuation devices and practices, and institutional changes.

In this paper, we focus on the specific case of the Holstein breed, the black and white cow that has become the most common dairy cattle breed in industrialized countries. The market for its genetics, mainly through semen, represents 335 million Euros in monetary flow between countries. Transforming the Holstein cow into a “milk machine” (Ruet 2004) relied on the tremendous development of data and calculative devices (heavy computations) to evaluate and govern previously incommensurable living entities. Although this cow is sometimes considered as a “machine”, it also generates high complexity in terms of the valuation and evaluation that farmers and breeding companies produce or consider as legitimate. This complexity manifests in the multiplicity of socio-biological entities that are constructed, diffused, exchanged and institutionalized through (e)valuation practices.

In relation to economic sociology, which has mainly focused on how commodities acquire value, we argue in this paper that evaluation devices co-evolves with the evaluated objects / subjects and the institutionalization of new social and biological entities. More specifically, we address the issue of which role new evaluation devices play in the emergence of new practices and new social entities, under the condition of institutional disruption, meaning changes to historically anchored institutions and the creation of new ones. To address this issue, we focus on contracts as a boundary object between organizations and markets where values are both framed and enacted. Contracts refer here to formal agreements between breeding companies and farmers related to the creation of genetic products, such as animals, embryos, and semen. Indeed, the phenomenon of contracting represents one of the major evolutions in the relationship between our societies and nature (Bellivier et Noiville 2006).

In this paper, we first draw on existing literature to identify how the bridging of institutional theory and valuation studies can help us better understand current changes in the commoditization and government of life. Second, through an empirical study we open the black box of breeding contracts to detect what they can reveal about how new evaluation devices contribute to the evolution of the evaluated objects / subjects, and the institutionalization of new social and biological entities. Third, we discuss the outputs and limits of this very early step in our empirical analysis of animal genetic markets under the institutional disruptions associated with the “genomic era”. We conclude by drawing some lines of inquiry for further research.

LITERATURE REVIEW AND RESEARCH QUESTIONS

Evaluation devices: constitution and effects

The call for this EGOS sub-theme suggests that the topic of organizational valuation and evaluation become the subject of an explicit sociological research agenda (Bidet *et al.* 2003; Karpik 2007; Vatin 2009; Vatin *et al.* 2010; Bidet *et al.* 2011). As a contribution to this agenda, we propose to bridge institutional approaches with valuation and evaluation studies.

Contemporary valuation studies, which were initiated by pioneers in French economic sociology, have primarily shed light on two main groups of questions:

- How commodities acquire value, including how value is “produced, diffused, assessed and institutionalized” (Lamont 2012), how people attribute and assess value in everyday life (Lamont 2012; Vatin 2013), and what role organizations and the institutional environment play in these valuation processes.
- The effects of (e)valuation practices, including what valuation practices and evaluation devices *do* to organizations and institutions, what do they produce in terms of knowledge, power and social entities, and how do they participate in social construction.

To illustrate the first group of questions, the seminal work of Karpik on valuation of expertise and the economy of singularities (1989; 2007) in the French economic sociology community, is a good example of studies focusing on how valuation devices support the functioning of markets for otherwise incommensurable goods, how do we attribute a monetary value to intangible things. More recently, Aspers and Beckert (2011) have identified several studies on valuation in markets that demonstrate “the crucial role organizations play through their identities (White 2008), their positioning of products in the market (Power and Hauge 2008), their creation of standards (Brunsson and Jacobsson 2000) and their introduction of judgment devices” in valuation processes. “Marketization” studies have focused their attention on the role of “valorimeters” (tools, procedures, machines, instruments or devices) in effecting a “controversial translation of values into figures and, more precisely, into monetary amounts” (Caliskan et Callon 2010). These studies focused on the design of these valorimeters “(by agents and/or by social scientists and especially economists, marketing professionals, experts in accounting or in the evaluation of costs and in management control), their implementation and their use, whether these prices correspond or

not to the transactions actually carried out” (Caliskan et Callon 2010). They study the asymmetrical relationships generated by the unequal distribution of calculating competencies as the heart of the marketization research programme. In this realm of studies which focuses on how value is attributed on markets, scholars have analysed the role of specific actors and their knowledge systems in the construction of value (Zelizer 1978; Callon 2002; Karpik 2007; Aspers 2009), and "how market actors arrive at judgments on the qualities of products offered in the market" (Beunza et Garud 2007). Beunza and Garud (2007) have shown how financial analysts cling to the use of established formulas for assigning a value to shares issued from emerging companies that develop new technologies. Fourcade identified “the unique role economists play in the legal system - specifically in the American legal system at the end of the 20th century - and the consequences of this role on the social construction of value” (Fourcade 2011). In these studies, “goods” are often considered as given, and the focus is on the process of their marketization.

The second group of works have addressed the question of the institutional conditions of the construction of value, and how technical evaluation devices and valuation processes become institutionally embedded (ref to be added). Other studies focused more on “what valuation and evaluation does” to organizations, practices and markets, considering the indivisible character of evaluation, values and objects of valuation and evaluation. For Espeland and Stevens (Espeland et Stevens 1998), “commensuration can change our relations to what we value and alter how we invest in things and people” and “some instances of commensuration are so deeply institutionalized that they help to constitute what they purport to measure”. More recently, Espeland and Sauder (2009) have demonstrated how organizations respond to evaluation devices through self-fulfilling prophecy (which changes behaviour in relation to altered expectations) and commensuration (which transforms cognition by changing the locus and form of attention, both creating and obscuring relations among entities). Podolny and Merryman (2004) have shown that “an assessment in terms of an underlying basis of commonality reduces the value of what is assessed”. Kaliskan and Callon (2010) summarized how further research has shown that “the tools equipping agents that enable (or habilitate) them to undertake certain types of action are not only instruments used to reach certain ends, but they contribute actively to making the realm that constitutes the action itself as a possibility (Hopwood et Miller, 1994; Miller, 1994; Miller et Rose, 2008; Power, 2004)” (in Callon 2010). Whereas Beunza and Garud (2007) and Fourcade (2011) detail the role of specific actors in valuation processes, authors such as Miller and O’Leary

(1987) have identified side how accounts help to “construct such organizationally consequential beings as the average worker, the ideal worker, and the suboptimal worker” (Miller & O’Leary 1987). “Quantitative measures of performance and benchmarking are diffusing rapidly and are having important structuring effects on a range of institutions and domains of human activity (Espeland & Stevens 2008, Lascombes & Le Gale’s 2005, Power 1997)” (in Lamont, 2012). Performativity theory has also contributed to the question of what evaluation devices and models do on markets and social reality. The aim in the performativity programme is to study all the theoretical and practical, expert and lay knowledge, know-how and skills developed and mobilized in the process of designing and managing market socio-technical agencements (Caliskan and Callon 2010). Muniesa & Callon (2008) describe the case of marine resources and the measuring tools used to manage them: these tools are devices that allow for the construction of economic scarcity and the existence of economic conducts. Performativity is about the role of knowledge in the constitution of reality (ibid). The most recent works in this performativity program have started to extend the question of performativity to the effects of evaluation devices on practices and how they participate to the making of the valued objects (Doganova 2015), an emerging research agenda to which our proposition here seeks to contribute.

The necessity to bridge institutional theory and sociology of valuation has been underlined and explored in previous work. Institutional sociologists have emphasized the ability of commensuration to create new social relations and even new social entities: “Studies of the elaboration and worldwide diffusion of census activity (Ventresca 1995) and of formal accounting procedures (Meyer 1986, Miller & O’Leary 1987, Carruthers and Espeland 1991) show how particular measuring, recording, and ranking processes help to make and remake phenomena they ostensibly describe” (Espeland and Stevens, 1998, p. 338). For these authors, commensuration does more than produce new relations; it can also produce new entities. They argue that “preponderant administrative practices create what they purport to describe” (ibid, p. 338). “Social critics from Simmel to Foucault have sought to portray how modernization reconstitutes human subjectivity and transforms long-established social relations. Examining particular instances of commensuration may enable institutional scholars to better discern the mechanics of those changes. Recent theoretical work underscores this potential” (Espeland and Stevens, 1998, p. 339). It seems that even recently there is still a need for investigating such questions, as Lamont (2012, p. 203) illustrated: “a growing number of European social scientists have studied plurality of regimes of worth, including transition between regimes

(Beckert 2008, Beckert and Aspers 2011, Boltanski and Thévenot 2006 [1991])”. “In parallel, a growing number of North American social scientists have studied institutional logics in organizational studies (Friedland & Alford 1991; also Lounsbury 2007, Thornton & Ocasio 1999, Thornton et al. 2012). These various literatures have not been in systematic dialogue with one another and function largely as independent silos defined by different substantive or institutional cores and networks of social interaction” (Lamont, 2012).

Despite these insights, much remains to be understood in the relationship between valuation and evaluation devices and practices, on the one hand, and institutional changes, on the other hand. Thus, there is still an avenue for research on how evaluation and valuation devices and practices create or disrupt institutions. We see a particular opportunity to link sociology of valuation and evaluation (SVE) to recent issues in institutional theory issues on where and how new practices and new institutions emerge (Lounsbury et Crumley 2007). One option could be that SVE could contribute to recent research in institutional theory on the emergence of new institutions. In turn, institutional theory could contribute to SVE in broadening the understanding of the role that evaluation and valuation devices and practices play in the creation of new social entities.

To aid in this broader theory-building effort, we explore, through an empirical case, the creation of new animal evaluation practices in the dairy milk industry. Our aim is to illuminate the evolution of practices and institutions under a new regime of evaluation (genomics). We explore how institutional and SVE scholarship can be combined to shed light on the creation of practices and social entities... To analyse the institutional constitution and effects of evaluation devices and practices, we empirically examine a specific artefact: contracts.

Contracts

Contracts are a technique of liberalism (O'Malley 2000) and a way of governing practices in the future. They also participate in the constitution of liberal subjects (O'Malley, 2000) and can be considered a boundary object linking organizations and markets. Previous research has mobilized contracts for different purposes. For instance, the study of contracts is an opportunity to contribute to the recent development in organization studies on the functioning of markets from an organizational point of view (Ahrne *et al.* 2015). According to Karpik (2007), contracts are one of the devices or “symbolic and material configurations” that intervenes to ensure the functioning of markets for singularities. Contracts are an interesting

object for examining value and valuation at the crossroads of sociology, economics, law and management in as much as they support inter-organizational cooperation and reorganize markets. As a socio-technical mean of calculation and mediation between different types of values (not only economic ones), contracts account for and value goods or services that does not exist yet.

We study contracts as a mean to access the patterns of evaluation practices. Our aim is to illuminate the link between new calculative devices and institutions through the analysis of contracts. Other types of artefacts have been used in neo-institutional studies to examine the institutionalisation of practices (Gond et Boxenbaum 2013; Jones et Massa 2013). We seek to extend this orientation to the study of contracts as an analytical window into the emergence of new institutions. Contracts are embedded, for instance, in doctrines and they also reflect institutional logics. We conceptualize contracts as a reflection of doctrines and logics and inquiry into the forms of subjectivity they convey and how they participate in enrolling actors into an alternative institutional logic.

Valuation of animals

The relation between societies and animals is of increasing topicality in social sciences and more specifically organization studies (Haraway 2008; Pina e Cunha *et al.* 2008; Hamilton et Taylor 2012; Labatut *et al.* 2014; Drake 2015). The market of farm animal genetics has since the 1950's linked genetic sciences and bioinformatics to the economy, hence offering a great opportunity for addressing research questions related to valuation and evaluation practices and processes. Indeed, animals and plant genetics, alongside agricultural chemicals and fertilizers, constituted two pillars of agriculture industrialization in the past century.

An increasing area of research pertains to the governance of nature and to governmentalities associated with attempts to manage nature, including the role of numbers (Enticott 2001; Fourcade 2011; Huault et Rainelli-Weiss 2011). In the realm of animal productions and management, previous works show how government and scientists organized national evaluations of animal performances and genetic merit, creating public metrics to “govern at a distance” and exert a powerful discipline (Foucault 1993; Power 1997; Sauder et Espeland 2009) on animal and farmers populations, organizing at the same time a market for genetic products (semen, living animals) (Gibbs *et al.* 2009; Labatut *et al.* 2011; Labatut *et al.* 2012; Labatut 2013; Labatut *et al.* 2013). This apparatus of national evaluations has recently been subject to disruption. The liberalization of animal breeding markets and the development of

new evaluation technologies (genomics) led to the emergence of a new regime of evaluation (Espeland and Stevens, 2008; Labatut et al. 2013).

Society assigns different values to animals and mobilizes various indicators to describe them. For instance, animals are associated to market values (e.g., their price on the livestock market), genetic values (e.g., selection of sires and high performance females through indices calculated on a large number of criteria, including milk performance, milk quality, udder, calving ease etc.), legal values (e.g., animals recognized as “non-human person” or “sentient living beings), or aesthetic and sentimental values (e.g., farmers’ participation in animal competitions, their knowledge of animal lineage, etc.). Scholars have started to analyze the effects of conflicting values on animals. Thus, Holloway (2005) examined “intertwined modes of bodily evaluation and genetic understanding evident in relation to ‘modernizing’ tendencies in contemporary agriculture, using a case study of pedigree cattle breeding”. However, much more remains to be done to understand how new technologies in the realm of living entities and incommensurable things change the way societies value, evaluate and govern animal populations.

Doganova et al. (2014) emphasize the analytical fruitfulness of moments of innovation for analysing valuation practices: “The ‘de-description’ (Akrich 1992) of valuation devices, which can be seen as a form of critique, is made easier in moments when valuation techniques and practices are contested and new ones are proposed” (Doganova et al. 2014). The international cattle industry currently faces such a typical moment. We set out in this paper to study how valuation practices involved in the Holstein breeding industry in the new “genomic era” facilitate substantial changes in the government of domestic animals and human populations on the market for animal genetics. We focus on the increasing importance of specific genetics practices such as embryo transfer and embryo production.

CASE STUDY

Contextual factors in the valuation of cattle

Before the recent development of genomics, animal breeding relied on breeding programs based on “progeny-testing” and statistical modelling of quantitative genetics. This method involved choosing the best animals based on the real performances (recorded) of offspring

and ancestors. Breeding companies were buying young calves from the best cows to farmers and waited five years until these calves became bulls with enough progeny (generated through frozen semen and artificial insemination distributed in farms all over the country) to be evaluated using geneticists' statistical models. This type of genetic selection was based on real performance (phenotypic measures) and genetic value was estimated with statistic models and official indices calculated by geneticists from national R&D institutes. Then, the best bulls were selected on the basis of their estimated genetic value and extensively used to generate the next generation of young males. "Progeny-testing" was a very long and costly process in the worldwide cattle industry: evaluating one bull use to cost about 40 000 euros, and breeding companies would definitely keep only one bull out of ten for commercial distribution (frozen semen). The few bulls selected at the end of the process could then become "stars" in the livestock industry. For example, the French Holstein bull "Jocko Besne" produced 1.730.000 sperm straws, engendered hundreds of thousands of daughters around the world, and was celebrated with his statue displayed on a roundabout in Brittany.

With genomic selection, as practiced since 2009, the evaluation process has been reduced from three years to an instantaneous evaluation (DNA analysis). As a result, many more bulls can be evaluated at lower cost (a genomic evaluation costs less than 60 euros). Genomic selection represents a change in the evaluation method used to select animals, not a technology using modified DNA. This new evaluation device relies on the use of DNA information (many genetic markers distributed all over the genome) to estimate the genetic value of animals with genome-wide dense markers on DNA chips. The first step consists in collecting data to create a "reference population" (a subset of animal population with large number of bulls and cows with genotypes and phenotypes). It allows for linking genotypes (specific status of all its genetic markers for a particular animal) to phenotypes (animal performances expressed) through prediction equations. These equations enable the relatively accurate estimation of genetic value (Estimated Breeding Value – EBVs) of unphenotyped animals (young bulls, heifers, and even unborn animals such as embryos) using genotyping results. These genetic indices are calculated for each targeted performance criteria (milk production, fertility, etc.). These indices are considered to be a reference for animal genetic value on the genetic market by breeding companies and farmers.

The efficiency of breeding programs to generate genetic gain on defined performance objectives depends on the identification of the best animals in the animal population, which is distributed across all farms worldwide. This procedure exploits the potential to produce

generations with higher genetic values. In a competitive environment, breeding companies have to be the first ones to find a promising cow in farmers' herds and to establish contracts on this animal with the farmer. Geneticists and bioinformatics firms that developed this evaluation technology have shown that it can fasten the production of genetic gain and increase certainty of the results for criteria that are difficult to measure (disease resistance, etc.). This technology enables cows to be evaluated with the same accuracy as bulls, which, as we demonstrate in this paper, have participated in radically changing the role of females in the market for genetic products.

Contracts in animal valuation

In the breeding industry, breeding companies establish partnership with farmers to valorise interesting animals through contracts. This type of contract is a signed agreement between a farmer and a breeding company specifying the purpose and economic and genetic conditions of use of a particular cow to generate progeny for the breeding company. They sign a contract on a young cow to produce embryos or young calves with selected and (possibly sexed) semen from the best bulls available on the breeding market (on bulls catalogues). The purpose of the contracts is to define rights and obligations of the contractors related to "exclusivity" or "priority" granted by the farmer to the breeding company for a specific animal object of the contract: a female (heifer or cow) belonging to a farmer, from which the company seeks to obtain high value embryos and then young males (calves).

A variety of contracts are created and used by companies, corresponding to different levels of interest or value of females as identified by breeding companies. Contracts on breeding animals are both an instrument of coordination between breeding companies and farmers and a process ranging from their design to their intended and unintended uses. They involve different types of actors: the managers of the breeding program in the breeding companies who design the contracts, the breeding program technicians who identify the animals and visit the farms and convince the farmers to sign the contracts, the farmers, the animals, etc. Their content, rewarding (royalties) and fulfilment system provide rules with an ability to materialize values assigned to animals in the process of creation of genetic gain, and to describe institutionalized practices for producing and selecting animals and embryos.

How valuation processes are involved in contract design and use (for example in the case of life insurance contracts) is an important but incompletely understood issue. This question has been mainly addressed in financial studies, through the development of valuation methods and

models in the realm of financial accounting and economic mathematics. We open the black box of contracts that are designed for setting agreements on living entities and intangible goods in order to examine the nuts and bolts of design and implementation of valuation contracts on animals. The study of breeding contracts is a way to better understand, “from the inside”, the co-evolution of valuation and institutions. We explore how animal genetic and economic values are integrated into contracts and predicted by them, how contracts redefine actors’ power and knowledge and new entities (both human and non-human), how genomics as a new “valuation technology” operate through breeding contracts to increase or diminish calculation capacities of certain kinds of actors, and how contracts extend the jurisdiction/authority of specific actors. The answers to these questions shed light on how new evaluation devices participate to the emergence of new practices and institutions in a context of institutional disruption.

Empirical setting

Our case study focuses on the selection of Holstein cattle in France and especially on how breeding companies and the farmers evaluate and value the best animals for genetic creation through breeding contracts. This breed was among the first in France and the first worldwide to be selected with genomic technologies in 2009. Three French breeding companies manage a Holstein breeding program and use contracts to find the best cows and sires on farms for the next generation of cows and bulls.

Data collection and analysis

The data collection was carried out in three stages. First, contracts (“partnerships” and “genetic creation” documents) were collected from breeding companies. Only two over three breeding companies accepted to diffuse their contracts. These two companies are very different in terms of size. One is the largest breeding company in Europe, the second one is the smallest breeding company for Holstein in France. In a second step, other information was gathered through observational sequences and ethnographic interviews with technicians in farms. Finally, several semi-structured interviews were conducted with breeding programs’ managers from breeding companies, other technicians involved in the genetic creation, and farmers involved in the breeding program.

To analyze the valuation practices involved in animal breeding, we follow two steps. First, we open the black box of contracts by describing how they embody animal present and future genetic and economic values, and how they constitute animal and human categories and markets. Second, we analyse contracts and valuation “in use” and their effects on institutional components: actors’ power and knowledge and the “agencement” (Callon *et al.* 2013) of farmers, animals and breeding companies. In this early draft of a paper, we focus *only on the first step of our research*: unravelling contracts for animal breeding, describing how they define economic and genetic values of animals and identifying new market institutions.

FINDINGS

How animals are valued in breeding contracts

Animal and contract categories

The contracts differ between the two companies. The contracts of the smallest company are entitled “Contract for male calves purchase”. This contract gives very little information on the type of females contracted or its genetic value. The breed is not specified (Holstein). The only rule indicated in the contract is on the sanitarian value of the female: she should have a negative result on the search for brucellosis, leucosis and tuberculosis (controlled livestock diseases). On the contrary, the breeding contracts designed by the largest company are highly detailed, descriptive and normative. They formalise very precisely what type of animals are subject to contracts, what are the obligations of the farmer and of the company, what are the different steps to follow for the production and sale of embryos. This company designed two interlocked contracts: a “framework agreement” and an “application agreement”. The “framework agreement” links the farmer to the company for all the animals of “genetic interest” in his herd. The company describes the company history, its aims and the managerial philosophy of its genetic program in the first page of the “framework agreement”:

“The breeding program of X (name of the company) in the Holstein breed creates males and females strategic animals, of high genetic value, in the aim of selecting and diffusing the products of the best ones of these strategic animals. Using genetic innovations, biotechnologies, the analysis and knowledge of genetic resources available in its farmers network, X makes every effort to allow its genetic creation to reach a level of excellence”.

The second part of the “framework agreement” is devoted to the definition of animal categories ("female", "herd", "generation"...), evaluation and reproduction methods ("genetic analysis", "genotyping...), actors and organizations ("Station", "network" ...).

The “framework agreement” allows farmers to benefit from the various “application agreements” proposed by the company. The “application agreements” are specific to one animal (female) in the herd and depends on its genetic value. The breeding companies select a first group of females according to the genetic value of their parents. These females are then genotyped and evaluated based on their genomic information. This evaluation can be paid by the breeding companies (for the females with the highest potential) or by the farmer (when their expected genetic potential is *a priori* less important). The result in terms of genomic evaluation and genetic interest (pedigree’s originality, genetic profile...) for the company’s genetic needs determines whether or not the female can be subject to an “application agreement”.

There are seven different application agreements available to farmers.

Five of them are contracts for embryos production with a selected cow: “strategic exclusivity”, “strategic exclusivity second generation”, “strategic priority”, “reference” and “resource”. According to the definitions given by the document, a "strategic female" is defined as a "female valued by [the company] to its major genetic value and exploited in its breeding program, subject of an application contract ‘exclusive strategic’ or ‘strategic priority’". These five agreements correspond to five categories of females defined by the company according to their genetic value and its potential to give birth to more or less high value animals. These different females categories (what these categories mean in terms of genetic values) are not defined in the contracts. The “article two” indicates which cow is related to the contract, specifying: the breed (Holstein), the female qualification by the company, the name and the national identification number of the cow and its first ancestors. In this section, the farmer declares that he is the owner of the cow. Thus, the contract refers to the French civil law by indicating that the cow must not be submitted to an exclusivity or priority application agreement with another company.

The last two “application agreements” concern the business of embryos already produced: “optimal” and “capital” contracts. These application agreements are contracts for embryos’ purchase by a farmer who wants to buy « new genetic ». The subject of these contracts are the « recipient cow » which will receive the embryo.

Il faudrait expliquer pourquoi ici (est-ce parce que ces informations sont stratégiques pour l'entreprise dans un contexte concurrentiel, est-ce parce que ces valeurs qui déterminent les catégories fluctuent en permanence, ou parce que l'entreprise veut se laisser une marge de manoeuvre dans la façon d'évaluer ces animaux / de définir ces catégories ? → à compléter

par les éléments issus des données du terrain

Then, females are not used for their production capacities but for their reproduction capacities: it is used to produce embryos or to receive embryos and then to give birth to calves.

Valuing animals or biological functions?

Once the “strategic exclusivity” contract is signed, the farmer receives a first payment of, e.g., 1,000 euros in return for the exclusive right granted. This premium includes 250 euros “for the female rent or its female reproductive system renting”, 250 euros “for the exclusivity granted on the strategic cow” and the same price for its heifers. This part shows what “entity” is valued for the breeding program: it can be the female in itself, or more specifically its “reproductive system”. This shows how contracts give value (and institutional reality) to specific entities: commoditization of animals as a whole and commoditization of specific “functions” or specific parts of animals. Before the development of genomic evaluation, cows’ reproductive system was a less marketable object because cows and embryos’ genetic values were unknown (or only through their parents’ genetic value, which was highly uncertain). As they know with more certainty the genetic value of females, breeding companies rent ovaries, not cows nor their womb to produce embryos. By multiplying contracts and embryos production breeding companies and breeders multiply the chances to identify the best animal. They take advantage of cow reproductive system to maximize chances of getting the animal with the best genetic value.

Valuing embryos

Concerning embryos collection, the farmer has the choice to keep his heifer on his farm (and the breeding company collect embryos on the farm) or to give it to the company’s “embryos production station”. The embryos sales conditions in the contract indicate the existence of two embryos’ classifications (“optimal” and “capital”), which determine the rights and marketing conditions defined on these embryos. Then the contract details the different step of the embryo production and sale. There are two ways of producing embryos: using super ovulation treatment and artificial insemination (the embryos are produced in the

cow's womb) or puncturing oocytes and realizing in vivo fecundation. All embryos can be frozen. The next step is the sorting. The company does the sorting. Those rules are not made explicit in the contract. During the contract validity, the company has the mandate to destroy all the embryos that are not considered as useful for the breeding program. The selected embryos are then transplanted on "receiving cows", either on the farm where the embryos have been produced or on another farm. The company pays for transplanting "fresh" embryos (non frozen) and farmers has to pay for the transplantation of frozen embryos. A part of the embryos are not transplanted on the producer' farm. The embryos that are not transplanted on the producer's farm are diffused through a network of farmers.

Once female and male calves resulting from insemination or embryo transfer are born on a farm, they are genomically evaluated. If the first genomic evaluation of a male calf is of interest for the company, it is reserved and must stay on the farm until his transfer to a breeding station. The farmer receives a first payment by the company, based on the animal's weight. If the animal is then qualified to become future breeding bull, additional subsidy is given to the farmer. The choice between these modes of compensation was made when the contract was signed, i.e. before insemination: a pre-definite compensation or compensation based on expected benefits made by the company on the bull future semen's sales.

The creation of new practices and institutions

Opening breeding contracts provides an opportunity to identify the increasing role and diffusion of specific practices and organizational forms.

Institutionalisation of new organizations – evolution of labour division for reproduction: "embryos production station": the contracts show the externalization of the reproduction. For embryos production, farmers have the choice to keep the cow on farm or to rent it to the breeding company. In the second case, the female leaves the farm and is put in a "embryo production station" for several months (maximum 24 months) to produce exclusively embryos. This new organization has been created to externalize reproduction for high value genetic creation.

Institutionalisation of a market for embryos: before genomic evaluation, the market for embryos was limited and highly uncertain. The only information available on the embryos was the genetic indices of the parents, their performances and their physical traits. With

genomic evaluation, embryos can be evaluated before being sold and transplanted into a cow. The accuracy of the genomic evaluation is the same as for already living animals. Two pages in the “application agreement” of the largest company are dedicated to the production of embryos, their sorting, their transplant and their sales.

Development of accounting practices / business plan for genetic activities + financierisation des ressources..

The paradox of a fluctuating genetic value. D’un côté hypothèse du focus sur la valeur génomique par rapport à d’autres valeurs du fait de l’accélération de la vitesse du progrès génétique et du fait que les animaux soient de plus en plus jeunes (jusqu’à ne plus être “nés” – impossible d’associer d’autres valeurs – esthétiques ou performances réelles puisque l’animal n’est pas visible) → le processus de valuation des animaux est resserré autour de la valeur génomique ? Nécessité d’avoir des éléments du terrain pour alimenter cette hypothèse. De l’autre : la seule valeur sur laquelle les échanges se cristallisent est finalement une valeur fluctuante / incertaine.

Valuation and materiality : on se libère de la contrainte du temps de la generation animale (on divise par deux l’intervalle de generation).

DISCUSSION AND CONCLUDING REMARKS

This study shows that animal genetic resources are the subjects of evaluation and qualification process, which breeding companies and farmers engage in through the use of tools in the form of contracts. Contracts are one of the instruments for the commoditization of living entities. Contracts are a micro and macro lense to understand how an industry value animals on the market.

First, with the new development of contracts in animal genetic market, cattle embryos are commercialized on an international market. Breeding companies seek to achieve the best coupling between the best cows and sires to improve genetic progress in each generation. To be competitive in this market, breeding companies invest time and money in searching for strategic animals with interesting or original pedigrees and very good genetic values. Contracts allow companies to secure their supply of genetic resources. This strategy takes place in a highly competitive environment that encourages companies to propose contract

very early during the animal life. In addition, when breeding companies are very interested in contracting a heifer they offer a great to the breeder. It is common during cattle competition and auction sale that a heifer is on sale with several contracts proposed by several breeding companies. The number of contracts proposed is also an indicator of the strategic interest for an animal on the genetic market.

Valuation technologies can have an effect on the type of entities valued. With genomic technologies, animals can be evaluated much earlier. Thus, the strategic animal is no longer the cow with its own performances but heifers without known performance. They are much younger than before and the embryos become a key entity on the genetic market. For breeding companies and clients, cows and tested bulls are of less interest compared to the new strategic animals: heifers, very young sires and even not yet existing animals such as embryos.

Second, contracts are established to create new sires and cows with genetic progress. Breeding companies have marketed the bulls' semen offer with specific categories: milk production performance, milk quality, efficiency, durability etc.). Genetic valuation of cows and heifers is also associated with a "marketing qualification" related to these categories. Then, breeding companies make strategic choice to mate strategic animals according to genomic information in order to create a new animal with expected characteristics. The market segmentation of the breed creates new opportunities to adapt the semen offer for worldwide demand. As a possible effect of market segmentation, we observed the development of "branding strategies", destabilizing the "breed" category as an institution.

What remains to be done in this paper is to strengthen the link between the theoretical part and the empirical study in describing more precisely how, through the analysis of breeding contracts, we can identify the role new evaluation devices play in the commoditization of different biological entities (heifers, embryos, etc.) and institutional changes.

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