Economic Modeling and Valorization of Biobanks

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0. Introduction

Biobanks are service-provider infrastructures that offer access to biological resources for academic and industrial researchers. These centers make samples available to researchers, allowing them to test hypotheses and develop innovations. This research helps to improve the diagnosis and therapeutic management of patients. Biological samples are the essential input for the success of this innovation.

The management of these biological resources requires considerable scientific and technical expertise. Biobanks must comply with numerous legal and regulatory requirements, particularly concerning the collection and transport of samples and the management of personal data. This data represents all the information that relates to the sample and that allows its use in the best conditions. One of the difficulties for biobanks is to master the collection of this information. Sample production requires a great deal of coordination between various professions to produce a high-quality input.

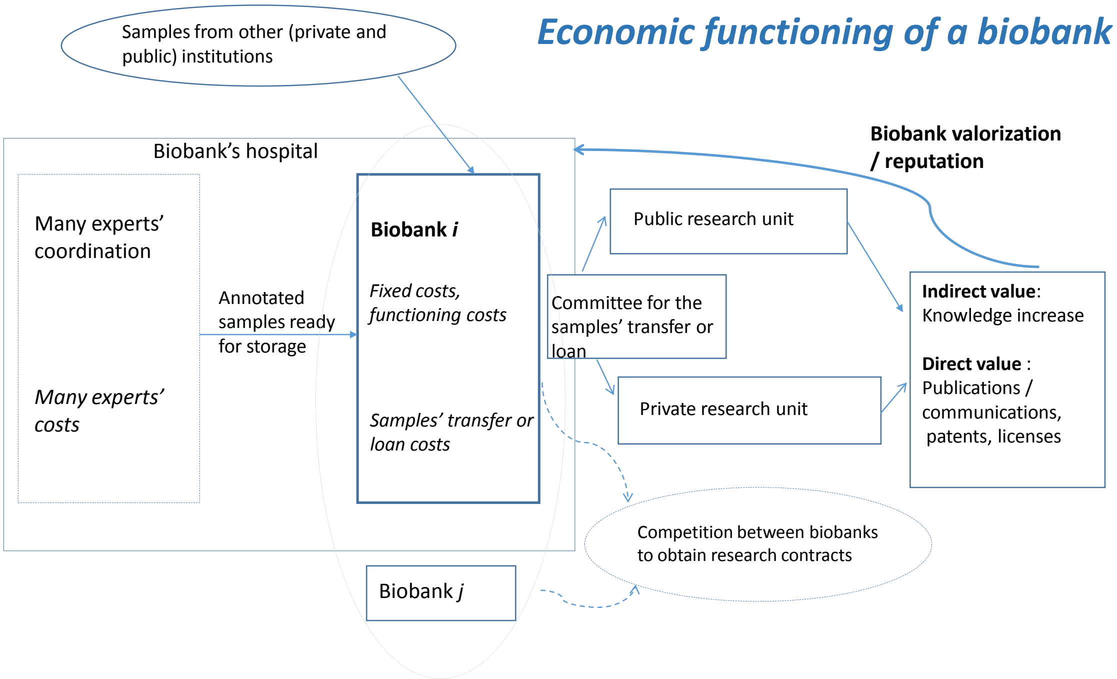
The problem of economic valorization of biobanks is thus mainly a problem of valorization of innovation: the biobank produces samples that serve as inputs for public or private research units. The success of innovation is highly dependent on the quality of the samples and on the degree of involvement of the various agents in the sample production chain. When providing samples, the activity of biobanks is potentially characterized by a significant problem of information asymmetries in its relationship with the innovator. The problem of economic valorization of inputs in the innovation process in the presence of information asymmetries has been studied in the economic literature. Many authors have analyzed what the contract between the different parties should be to obtain adequate remuneration for the effort and maintain incentives for innovation (Aghion and Tirole (1994), Tirole (1999)). In particular, these contracts call for distribution of innovation property rights between the different parties, and for payment of licenses and royalties.

Certain specificities of the activity of biobanks nevertheless require a focused economic analysis. Several biobank decisions affect the organization of input supply and thus determine the market for biological samples. These decisions may concern the strategic positioning of a biobank and determine the way it fits into the national and international landscape. They may also affect the operational functioning of the biobank. Thus, in addition to the multiplicity of agents for whom incentive compensation must be provided, the choice of the number of collections and samples is a decision variable that determines the specialized or generalist character of the biobank. The decision to network several biobanks is also crucial for the success and quality of innovation.

We offer here a description of the economic functioning of a biobank. This allows us to extract the fundamental elements for understanding not only the profitability and thus the viability of biobanks, but also the dynamics of the innovation process. We propose a framework allowing biobanks to analyze the economic issues related to their decisions.

I. Economic operation of a biobank

The structure of biobanks may vary from one facility to another, but we have identified elements that we consider fundamental to characterize the production and exchange of samples. The graph below provides a description of a biobank and highlights the various elements involved in its economic valorization.



The biobank is usually attached to a hospital where patients provide the vast majority of the samples. Some biobanks supplement their collection by obtaining samples from other institutions. Staff at the hospital establishments take samples for the care of the patients. With the authorization of the patients, part of the samples can be stored in the biobank with the corresponding data. This activity leads to fixed and variable operating costs (depending on the number of samples stored). It is important to note that the difficulties related to the coordination of different professions are an important part of the running costs.

The different research units acquire samples which represent the essential input of research that is fundamental or applied, private or public. This research can be conducted independently or in coordination with the biobank. The allocation of these samples to the research units can only be done with the agreement of the biobank. The provision of samples by the biobank is decided by a committee composed of scientific experts and staff representing the hospital's managers. While the private or public nature of the research unit may be a factor in the committee's decision, it is primarily focused on the scientific quality and scope of the research project. Some samples are permanently transferred, the biobank giving up all control over their use; others are lent to the research units, paving the way for scientific collaboration with the biobank.

The exchange of samples between the biobank and the research unit is formalized by a contract defining the rights and obligations of the various parties. Certain economic characteristics are crucial in the exchange and in the success of innovation. The tariff at which samples are exchanged seems to depend on the nature of the research unit (public or private). Property rights, licenses and royalties complete the terms of the contract. These monetary transfers paid by research units must at least cover the biobank's running costs. It is important to emphasize that the different monetary transfers depend on the bargaining power of each actor and notably on the degree of competition between the different biobanks for the same project.

In addition to the various elements mentioned above, the economic valorization of the biobank cannot be dissociated from the success of the innovation. This innovation is an improvement in knowledge but its outcome is uncertain. The impact of an innovation can be monetarily and academically assessed. Patents, licenses and publications are thus the key elements in evaluating the quality and reputation of a biobank.

It is important to consider this exchange between biobank and research unit within a market framework. In the national or international landscape, biobanks may have a varying number of competitors when the research units choose the source of the samples. This raises the issue of the pooling of several biobanks, for example in a network. Operating costs can be reduced and the supply of samples to research units becomes more attractive. This networking also improves the bargaining power of biobanks. It may, however, require the biobanks to accept a certain loss of control of their collection. A biobank can also lose its specificity and reputation.

This description of the economic functioning of a biobank allows us to identify the specific challenges of biobank valorization that we develop in the following section.

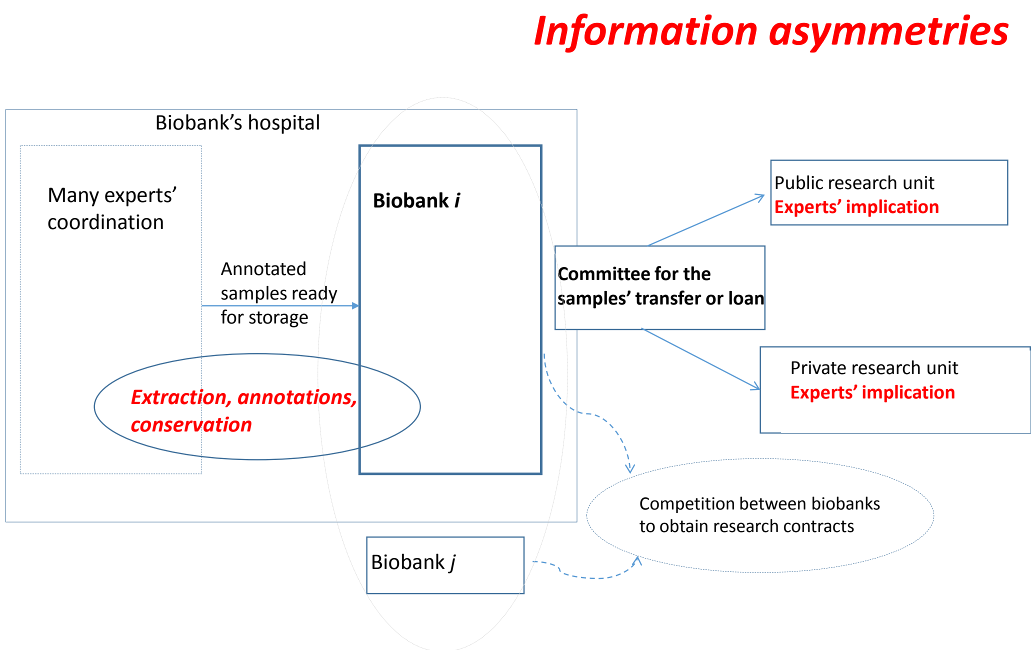
II. Challenges of valorization

II.A Information asymmetries

The quality of the samples is fundamental to increasing the chances of success of the innovations developed by research units. This quality may, however, be subject to information asymmetries which inhibit exchange and restrict the possible contracts between the various actors.

In economics, information asymmetries between different parties take two forms. *Adverse selection* refers to the case where one party holds private information that it cannot manipulate and which is not observable by the other party. *Moral hazard* refers to the case in which one of the parties performs an action (this is called "*effort*") that it can manipulate and which is not observable by the other party. Information asymmetries may concern biobanks and research units.

The graph below identifies potential sources of information asymmetry in the operation of a biobank.



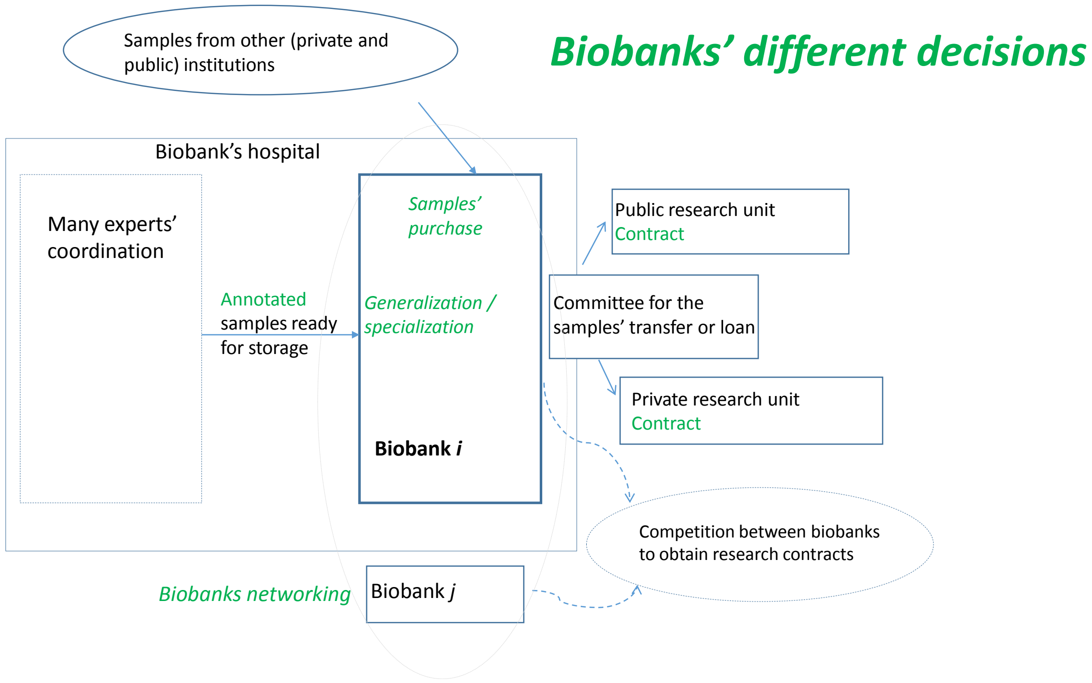
The biobank is faced with a problem of adverse selection because the projects are carried out by different research units with different skills, proposing projects whose success and scientific impact are difficult to assess. This information asymmetry justifies the existence of a committee for the provision of samples, helping to identify the most promising research projects.

It may also be difficult for a research unit to assess the quality of a sample *a priori*, so there is a problem of adverse selection at the point when the contract is signed. This information asymmetry forces biobanks to signal their quality. Costly specific actions, such as certification or labeling, are often required. When the relationships between the various actors are repeated over the long term, with an academic record of the biobank's successes, biobanks acquire a reputation that mitigates this problem.

Moral hazard is the form of information asymmetry that is most often found in the management of biobanks. Indeed, it can intervene in two main stages: the "sampling, annotations, conservation" stage and the "implication" stage. The different professions can carry out the tasks of sampling, annotation and conservation with varying degrees of care and coordination. Additional work can sometimes be requested to complete the annotations. This can lead to significant variability in the quality of the samples. Experts may also be invited to participate in the project and provide scientific support to the research unit. The quality of the samples can thus be manipulated by the biobank, even after the contract is signed. This moral-hazard problem can generally be solved by making payment of the biobank conditional on the success of the innovation: the biobank must be rewarded so that it makes the effort suitable to the conditions of innovation (Aghion and Tirole 1994), Choi (2001)).

II.B. Biobank decisions

The description of the various tasks of the biobank highlights several decision variables displayed in the graph below.



II.B.1 Strategic positioning

First, the biobank must choose a *strategic position*. This can be done at two levels: the number of collections and the quality of the samples.

The decision to specialize in a small number of collections or to propose a wider range modifies both the degree of competition between biobanks and the biobank's expertise. Indeed, choosing a specialization in a particular collection allows the biobank to position itself uniquely in the scientific community and ensure it obtains a high level of visibility and recognition. Its expertise and thematic coherence will then be strong, enabling the biobank to reduce its operating costs. To complete its thematic collection, the biobank will be able to buy samples from other institutions (clinics, tumor banks or other biological resource centers). Specialization positions the biobank in a niche, giving it a certain monopoly power. Biobanks can also choose to offer several collections. By providing broader (but less precise) expertise, these generalist biobanks can be involved in a larger number of projects. However, the presence of several collections within the same biobank will involve professionals from several different specialties and therefore incur additional operating costs.

The second strategic position concerns the quality of the samples. Not only should annotation at the time of sampling be done very carefully to ensure optimal future use, but additional annotations can also be made at the time the samples leave the biobank to be used by research units. High-quality samples allow the biobank to vertically differentiate from its competitors.

According to these strategic choices, the economic landscape of biobanks can thus present several configurations which affect their valorization.

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Strategic positioning: several possible outcomes

	generalist biobank	specialized biobank
generalist biobank	- strong competition - low revenues - **outcome** : vertical differentiation with several samples’ qualities	- weak competition but on the common collection - **outcome** : - vertical differentiation on the common collection - high quality for the specialized biobank
specialized biobank	- weak competition but on the common collection - **outcome :** - vertical differentiation on the common collection - high quality for the specialized biobank	*same specialization* - strong competition - low revenues - **outcome** : vertical differentiation with several samples’ qualities *different specializations* - no competition - high revenues - vertical differentiation is less important

First, the terrain can be occupied by a *set of generalist biobanks*. These biobanks compete to attract projects. One possibility to limit this competition is to vertically differentiate. According to the quality of its samples, a biobank will align itself with projects with varying ambitions. Such differentiation gives all types of biobanks some market power (Choi and Shin (1992), Motta (1993)). We can also consider an economy composed of *specialized biobanks*. This specialization limits competition and offers a local monopoly to biobanks, reducing the problem of sample quality because each biobank is positioned on a different collection. Finally, *generalist and specialized biobanks* can coexist. Competition is strengthened, weakening generalist biobanks. One of the probable effects for the generalist biobanks is a willingness to limit their costs by choosing to produce lower quality samples. This results in a situation in which specialized biobanks obtain a privileged position if they take advantage of their expertise to offer high quality.

II.B.2 Conditions of exchange

First, the exchange cannot exist if the biobank refuses to provide samples. This decision is made by a scientific committee that studies applications from research units. The question of the involvement of biobank experts in research projects using the samples must also be asked. Selection of projects and involvement of experts result from the evaluation of the innovation by the committee. The expertise of the biobank is a crucial variable since it is easier to identify good projects when the biobank is specialized. The private or public nature of projects can also be considered. For example, a biobank expert will find it easier to work with researchers from public institutions if their common objective is to promote greater academic valorization.

When the exchange is accepted, it is necessary to determine its terms and conditions. A contract between a biobank and a research unit may specify lump-sum payments, royalties or a tariff for making samples available. The contract must depend on verifiable variables. Economically, it is necessary to determine the form and elements of the contract that best promote the success of innovation. The question of sharing the value of innovation is an additional question. This sharing is essentially determined by the bargaining power of each of the actors, i.e. their alternatives (another project or partner) if the negotiation fails.

The nature of the innovation, and in particular the extent to which it can be specified in the contract, is a fundamental element in the economic analysis of the contract between the biobank and its partner. The role of each agent in the success of innovation is very difficult to define. From an economic point of view, it is important to understand how the terms of the contract between the biobank and the research unit affect the value of innovation.

The *form* of the contract is important when the biobank wants to convince its partner of its quality and limit the problem of adverse selection. A biobank can signal its high quality by offering a contract with a lump sum at the time of signing the contract, plus royalties and a lump sum if innovation succeeds (Macho-Stadler and Perez-Castrillo, 1991).

The success of the innovation depends on the different characteristics or efforts made by each of the parties during the execution of the contract. The *elements* of the contract are then important because they modify the involvement of each partner in the relationship, thus responding to the problem of moral hazard (Aghion and Tirole (1994), Choi (2001), Dechenaux, Thursby and Thursby (2011)).

One of the specificities in this innovation is that it relies in part on the exchange of a tangible good: the sample. Thus, contracts typically specify the tariff for which samples are made available. Biobanks must adjust their rate in relation to the marginal cost of production. In practice, it appears that biobanks engage in price discrimination according to the nature of the research unit. Public research units are offered a lower rate than their private counterparts. According to economic theory, such price discrimination is rather inefficient (Tirole (1988)). In this complex relationship, this rate also varies according to the involvement of actors who can support such discrimination.

If it is possible to specify all the obligations of the parties in the contract, then it is possible to obtain the appropriate level of effort with a contract specifying a lump-sum payment between the biobank and its partner (the result of the relationship is independent of the amount of the lump sum). When the obligations of the parties can no longer be specified in the contract, a fixed payment is no longer optimal: the biobank must be compensated for the level of effort provided.

II.B.3 Networking

Biobanks' networking initially entails significant standardization and coordination costs, but it increases both the visibility of biobanks and the accessibility to samples. The standardization of production processes leads to a reduction in operating costs. Moreover, this networking limits the competition between biobanks, favoring negotiation with a research unit.

However, this networking involves additional costs for biobanks that are linked to information asymmetries. Networking can only be successful if all partners have a sufficient level of involvement. This level of involvement will inevitably be affected by networking to the extent that each biobank is associated with other biobanks in the success of a project. The dilution of the responsibility of each biobank leads to a free-rider problem as each biobank can benefit from the work of the others.

In case of voluntary networking, we must understand what is at stake for a biobank in deciding to participate. Expertise is still a key issue. It is more difficult for a specialist biobank to justify participation in the network: it must share the fruits of its specialization and expertise with less experienced biobanks and therefore accept a certain loss of control of its collection. A biobank that is more experienced will be more concerned with the problem of free riders. A specialized biobank, on the other hand, will be keener to network if this allows it to access research projects that the biobank cannot manage on its own. It is therefore essential that the sharing of samples or collections adds value to the biobank (Casamatta and Haritchabalet (2007)).

The positive effects of networking are more important for generalist biobanks. Increased visibility allows them to participate in more projects, and in projects that are more ambitious. Collaborations with specialized biobanks also enable generalist biobanks to increase their expertise, which in the long term has a positive effect on the quality of innovation (Tykvova (2007)).

III. Conclusion

We have highlighted the interactions between strategic positioning, conditions of exchange and information asymmetries. It appears that the level of expertise is a key element both in the economic valorization of biobanks and in the success of innovation. This level of expertise determines the position on the quality scale as well as the degree of competition between the different biobanks.

IV. Bibliography

AGHION, Philippe and TIROLE, Jean. The management of innovation. *The Quarterly Journal of Economics*, 1994, vol. 109, no. 4, p. 1185-1209.

CASAMATTA, Catherine and HARITCHABALET, Carole. Experience, screening and syndication in venture capital investments. *Journal of Financial Intermediation*, 2007, Vol. 16, no. 3, p. 368-398.

CHOI, Jay Pil. Technology transfer with moral hazard. *International Journal of Industrial Organization*, 2001, vol. 19, No. 1, p. 249-266.

CHOI, Chong Ju and SHIN, Hyun Song. A comment on a model of vertical product differentiation. *The Journal of Industrial Economics*, 1992, p. 229-231.

DECHENAUX, Emmanuel, THURSBY, Jerry, and THURSBY, Marie. Inventor moral hazard in university licensing: The role of contracts. *Research policy*, 2011, vol. 40, no. 1, p. 94-104.

JENSEN, RICHARD and THURSBY, MARIE. Proofs and Prototypes for Sale: The Licensing of University Inventions. *The American Economic Review*, 2001, vol. 91, No. 1, p. 240-259.

MACHO-STADLER, Ines and PEREZ-CASTRILLO, David. License contracts and information asymmetry. *Annals of Economics and Statistics*, 1991, p. 189-208.

MOTTA, Massimo. Endogenous quality choice: price vs. quantity competition. *The Journal of Industrial Economics*, 1993, p. 113-131.

TIROLE, Jean. Incomplete contracts: Where do we stand? *Econometrica*, 1999, vol. 67, no. 4, p. 741-781.

TIROLE, Jean. *The theory of industrial organization*. MIT press, 1988.

TYKVOVÁ, Tereza. Who chooses whom? Syndication, skills and reputation. *Review of Financial Economics*, 2007, Vol. 16, No. 1, p. 5-28.