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# The heterogeneity of public ex situ collections of microorganisms: Empirical evidence about conservation practices, industry spillovers and public goods

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## ABSTRACT

Public service (ex situ) micro-organism collections serve to secure genetic resources for unforeseen future needs, and importantly, to provide authenticated biomaterials for contemporaneous use in private and public entities and as upstream research materials. Hence, it is important to understand the functioning and strategic decisions of these providers of public good resources.<sup>2</sup> The existing literature tends to use case studies of individual collections. This paper uses a unique worldwide survey of microbial collections to analyse the heterogeneity among culture collections, and to empirically assess the economic and institutional conditions that contribute to this heterogeneity with respect to conservation choice and associated industry spillovers. Results suggest that in the short run public-private partnerships may indeed support knowledge accumulation with particularly strong public good properties. It is important to be aware of this strong tie, in order to steer also the long term conservation patrimony into one that offers not only short term usability but also resilience to future unforeseen needs e.g. of emerging crop plagues.

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## 1. Introduction

In recent years, the life sciences research community has been involved in a vigorous debate over what should and should not

be in the public domain. Many of the discussions have been over preserving public access to basic research assets, such as basic biological research materials and genomic databases. The debate has been accentuated by the profound changes in

<sup>2</sup> Here we refer to public goods in a general way as goods which are relatively costly to exclude others from using, and, whose consumption by one user does not in a significant way reduce the quantity of the good available for others to use.

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the organisational structure and the funding of life science research infrastructures, especially since the early 1990s, when the commercial promise of genomics became apparent, and private funding for genomics in for-profit companies began to accelerate (Cook-Deegan and Dedeurwaerdere, 2006).

Much scholarly research on these new organisational and institutional mechanisms for providing public access to basic knowledge resources in the life sciences has focused on human genetics and plant breeding (Harvey and McMeekin, 2007; Overwalle, 2009). This paper aims to contribute to the understanding of these changes by focusing on a case study within the particular field of microbiology. The reason for this choice is double. First, the international network of public culture collections historically has been one of the first global research infrastructures providing public access to basic biological research materials (Stern, 2004; Reichman et al., 2013), held in a distributed network of collections throughout the world (Smith, 2003). Second, the importance of these public collections has grown over the last two decades, with their transformation to multi-service biological resources centres, which provide expertise in genetics and bioinformatics, in addition to their traditional taxonomic expertise (OECD, 2001). As a result, the network of public microbial collections has increasingly evolved from purely governmental institutions to a heterogeneous group encompassing both public sector and private sector funding strategies. Therefore, culture collections is an interesting case of a research infrastructure providing publicly available knowledge assets, whose organisational structure is increasingly based on public-private economic interdependencies (please refer to the electronic supplement for additional background to PSMCs).

The role and functions of the microbial collections as a basic life science research infrastructure bears a lot of similarities with other *ex situ* collections, especially in the field of animal and plant genetic resources, which have been studied elsewhere (Fowler et al., 2001; Gollin et al., 2000; Roa-Rodríguez and van Dooren, 2008; Mäki-Tanila et al., 2008). However, two important features are specific to the microbial collections. First, microbial organisms have an extremely high genetic variation within species and very high mutation rates upon reproduction. As a result, there is no equivalent to the relatively well-defined species concept for plants and animals. Therefore microbial science depends on the *in vitro* organisms held in the microbial *ex situ* collections. This explains the importance of a broad range of wild biodiversity held and still massively collected by the microbial collections, while the *ex situ* conservation efforts in the agricultural plant and animal collections that have been the focus of previous studies the main focus is on domesticated varieties and breeds (Halewood, 2010). Second, the public microbial collections provide on average a comparable amount of materials to public sector and private sector entities in the life sciences. This hybrid character of the distribution practices of the public microbial collections makes this case a rich source for quantitative analysis of conservation and distribution strategies in life science research infrastructures.

The main objective of this paper is to enhance our understanding about the organisational heterogeneity amongst public service culture collections, which increasingly include hybrid public-private funding strategies. In particular

the paper aims to analyse core aspects of the economic and institutional conditions that contribute to PSMCs' conservation of microbial material and its distribution as publicly available basic knowledge assets for life science research. It is expected that this analysis will contribute to the design of strategies that secure the sustained long term conservation of microbial material with public good properties. This seems especially relevant in the context of uncertainty created by recent changes in the institutional landscape in which PSMCs operate, for instance due to the stress on public funding for basic research and infrastructures, and the increasing commercial interest by the industry in microbial resources generally.

To this end primary data about the PSMCs' conservation and distribution was gathered through a worldwide survey and a sample of 103 PSMCs is subjected in this paper to statistical analysis. We find that (1) the private industry relies on PSMCs; (2) hybrid arrangements based on complementary public and commercial funding is associated with stronger specialisation in microorganisms with particularly strong public good properties and (3) the existence of public-private interdependency. These results call into question the role of markets alone or pure public funding alone for assuring the provision of publicly available biological resources in a globalised research context.

The next section addresses the key factors behind the organisational heterogeneity of PSMCs. Then the analytic framework discusses the factors that are expected to play a role in the public and private investment in the PSMCs' conservation strategies regarding publicly available microbial type strains. We also introduce the related question about spillovers from PSMCs to the private industry (Section 3). Section 4 presents the materials and methodology of the statistical analysis; Section 5 presents the results and discusses their implications. The last section concludes.

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## 2. The heterogeneity of public service microbial collections

### 2.1. PSMCs as an infrastructure for public research materials in the genomic area

PSMCs link academia, industry, government and international knowledge providers and users of microbial material. As such they are knowledge hubs, *sensu* Stern (2004), for the life sciences that support innovation by facilitating acquisition of and access to existing research materials (Furman et al., 2010). This is done through a worldwide network of centralised deposit and access services. As knowledge aggregators, they can be considered as the research libraries for bio-materials. See electronic supplement for further background and description of PSMCs.

One particular element in this research infrastructure is the microbial category known as *type strains*, which are the basic reference materials for identifying microbial taxa. As such type strains are a fundamental part of the general research infrastructure in microbiology that serves applied and basic research, both for public sector and private sector users.

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