Coordination modes in public funding systems

Benedetto Lepori

CORe - Centre for Organisational Research, Faculty of Economics, University of Lugano, Via Lambertenghi 10a – 6904 Lugano, Switzerland

+41 58 666 46 14

benedetto.lepori@usi.ch

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Abstract

The aim of this paper is to look at public research funding systems from the perspective of their broader institutional arrangements, in order to observe how these shape the relationships between funding agencies and research actors. Accordingly, public funding is considered as a multilevel and multiactor system, where stable patterns are largely generated by the collective interaction among actors (beyond formal rules and structures) and where coordination between actors (especially funding agencies and performers) represent a key for the functionality of the systems. This drives to characterise the main organisational forms of public research funding in terms of their underlying coordination mode and to use this framework to evaluate them against a number of criteria. Further, the way how these organizational forms can be combined to yield national-level configurations is discussed, and some of their properties and conditions of functioning are derived from the previous discussion; this leads also to identification of three main configurations of funding systems – the project-based model, the mixed model, the vertically integrated model -, which describe the variety of national systems and, to a large extent, underpin current discussion on European research policy.

Keywords: public funding systems, coordination modes, institutional complementarities

1 Introduction

The aim of this paper is to look at public research funding systems from the perspective of their broader institutional arrangements , in order to observe the way how these shape the relationships between funding agencies and research actors. While funding systems have always been a central concern in research policy studies - a fact which can be hardly surprising, given the distributive nature of this policy domain (Braun and Gilardi 2006) -, a review of the literature shows that they have been rarely addressed from this perspective (see however Benner and Sandström 2000 and Whitley 2003). This limitation is unfortunate, since some of the most relevant research policy issues cannot be addressed adequately without a broader institutional approach.

Broadly speaking, the studies in the field can be classified by distinguishing between those focusing on the policy and on funding agencies and those addressing the choices and behaviour of research actors, at the level of individuals and research groups, as well as of whole research organisations.

A number of studies have focused on the design of research policies and on how these impact on the mix of funding instruments (see Guston 2000; Larédo and Mustar 2001); comparative studies have also looked at similarities and differences between countries and they spurred the debate on convergence of national research policies vs. national specificities (see Elzinga and Jamison 1995; Senker et al. 1999; Lemola 2002). More specific analyses have dealt with funding agencies and with the portfolio of instruments, looking at the role and organisation of research councils (Braun 1998; van der Meulen 2003; Slipersaeter et al. 2007) or at the composition of public project funding (Lepori et al. 2007). A rather distinct tradition in Higher Education Studies deals with principles and approaches for funding higher education institutions (Jongbloed 2008).

At the recipients' side, Sociology of Science and laboratory studies have focused on how the social organisation of sciences and its internal incentives drive the behaviour of individuals and the allocation of resources (Latour and Woolgar 1979), taking into account the role of credit as a central asset in science (Merton 1973; Dasgupta and David 1994). Recent work looks at the impact of changing funding schemes towards more utility and politically-driven priorities and it investigates the strategies of scientists for accommodating or shielding these changes (Laudel 2006), as well as their impacts on the working of science. Moreover, other studies have focused on the strategies of universities and public research organisations (PRO) to increase their funding basis and to respond to policy changes (Sanz Menéndez and Cruz-Castro 2003 for PRO; Jongbloed 2007 for Higher Education Institutions).

Accordingly, most works in the field focused on a single system layer, looking at responses of individual actors and at horizontal relationships between them (for example cooperation vs. competition), but largely considering changes in other layers (for example at the policy level) as external factors, while there is a lack of studies on interactions across institutional layers. The main exception has been the research line based on delegation and Principal-Agent Theory, investigating the relationship between state and the scientific community in terms of delegation modes (Braun and

Guston 2003; Braun 2003) or dealing with vertical relationships between State, funding agencies and researchers (Caswill 2003; van der Meulen 1998). Yet, in most of its applications, this approach tends to focus on the interaction between an individual agency and a set of researchers, overlooking the presence of multiple principals and the complex nature of network interactions between funding agencies, research groups and external stakeholders, for example in research programmes (Shove 2003; Klerkx and Leeuwis 2008).

Despite their value in modelling specific interactions, these approaches are hardly useful in addressing a basic question concerning research funding systems, namely to which extent different configurations of funding make a difference in terms of the system-level outputs and, correspondingly, which the most suitable mix of instruments is in order to achieve (different) policy goals. Moreover, it would be highly relevant to understand to which extent this configuration differs according to the characteristics of research (for example the search regime; Bonaccorsi 2008), but also of the broader social and political environment in which research policy is embedded.

It has been suggested that answers to these questions are more related to general institutional properties of funding – like the degree of fragmentation or the ability of quickly moving resources to emerging domains (Bonaccorsi 2007; Larédo 2008) – than to policy intentions and characteristics of individual instruments. The aim of this paper is to develop this argument by representing research funding systems as sets of interconnected spaces of interaction between different layers of funders and performers and by examining how these interactions are shaped by different institutional settings. The paper is thus inspired by work on the relevance of institutional arrangements for the working of science (Whitley 2003; Bonaccorsi 2007), as well as by approaches in institutional economics like socio-economics (Hollingsworth 2002) and comparative institutional analysis (Aoki 2001).

The argument is developed in four steps. Firstly, in section two, a view of public research funding as a multilayer system characterized by a multiplicity of largely autonomous actors is presented. This drives to look at research funding in terms of how actors coordination is achieved; accordingly, in section three, the notion of *coordination modes* is introduced, and their characteristics are discussed, while in section 4 the observed organizational forms of public funding, in terms of the underlying (combinations of) coordination modes, are analyzed. Finally, in section five, national configurations and dynamics are argued. The paper is concluded through a short discussion about the implications of this approach for future empirical work.

2 A framework on public research systems

Figure 1 provides an overview of public research funding, distinguishing among four organizational layers – the policy layer, funding agencies, performing organisations and research groups/individual researchers -, as well as between two main allocation methods, core funding to research organisations and project funding to research groups.

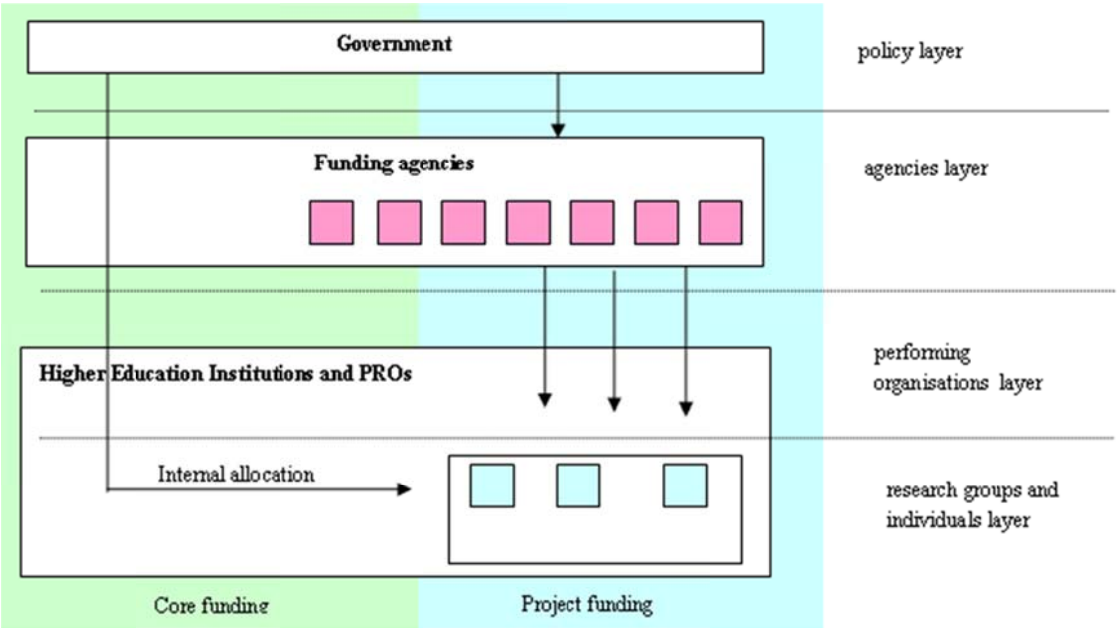

Figure 1. An overall view of public research systems

The identification of the layers builds on different traditions in Science Policy Studieswithin Policy Evaluation, they distinguish between the political level, where principles and strategies are defined, and the operational level of the agencies in charge of implementing policies; in Science Policy Studies they look at the central role of the intermediary level in sciences policies; finally, the principal-agent tradition works on the triangular relationship among State, funding agencies and research in.

The notion of "Government" has become itself fragmented and multilayered with the emergence of the European Union as a policy actor concerning research, but also with the increasing role of regional authorities (especially in federal states). Moreover, the term agency is here used in its broadest meaning, as long as it includes all types of operational units in charge of allocating some portion of public funding, also ministries and higher education funding agencies. While there is some understanding that these agencies are actors on their own (coherently with recent approaches on public administration; Braun and Gilardi 2006), their degree of autonomy (as well as of intermediation with the scientific community) can be highly variable from case to case.

The multiplication of funding agencies and instruments (Lepori et al. 2007) and the emergence of the European and the regional levels as relevant for research funding drives to replace the idea of an overall policy rationale and coordination of public funding with an approach based on a broad set of largely autonomous agencies and instruments. In this setting, soft coordination is ensured through mechanisms like the Open Method of Coordination (Borrás and Jacobson 2004), while mutual adaptation effects among the agencies themselves emerge (as witnessed with the creation of the European Research Council; see also the special issue of Science and Public Policy on limits of political coordination; Braun 2008).

The introduction of a third layer, namely "performers organisations" like universities or public research organisations, which constitute the organisational framework of research laboratories and groups, is explained by their increasing role concerning funding, largely as a consequence of new policy rationales granting them more autonomy. Research organizations assume a key role in linking the systems layers, since they are increasingly able to selectively mobilize their staff towards funding opportunities, but they also directly interact with policy and funding agencies. Moreover, performers' internal allocation policies are highly relevant for strategic purposes and they establish strong linkages between core funding to performers and project funding to groups and individuals, introducing a further feedback loop in the system.

Finally, the fourth layer is composed by research groups, or research collectives, considered as the main strategic actors in developing research programs and in managing the interconnection between financial and human resources from one side, knowledge production to the other side (Bozeman and Crow 1990; Larédo and Mustar 2000).

It is important to notice that *layers represent functions, not organisational structures*: even if in most cases they are organisationally distinct, cases of organisations spanning across layers are also documented: the most notable example being large PROs assuming some of the functions of a funding agency for their laboratories through internal evaluation and competitive allocation procedures (see Thèves et al. 2007 for the French CNRS).

2.1 From top-down steering to interaction spaces

Most Science Policy Studies embraced a top-down view of funding systems, where the State allocates resources to steer research. Main issues become the choice of the best instruments and allocation criteria to reach policy goals, as well as of suitable control mechanisms to avoid shirking by the performers (Braun and Guston 2003). However, the previous discussion shows that this view needs a further development: in a context where funding agencies, research organisations and research units are semi-autonomous actors which are able to act strategically to reach their goals, exploiting the resources and opportunities provided by the environment, there are no *a priori* hypotheses on which kind of actor drives the evolution of the system and could be considered as the principal in terms of the principal-agent framework. : for example, it could be argued that competition among laboratories takes place around critical resources – like highly reputed people (Weisenburger and Mangematin 1995) – and that, once these have been purchased, research products or services can be pushed upstream to funding agencies (White 2002; Morris 2003). It could be also argued that the highly ranked PROs and universities drive also the allocation of project funding to individual teams through their institutional reputation and ability to attract the best researchers.

Of course, while in this distributed setting the function of the State cannot be to steer each actor individually, nevertheless it keeps a distinct role: first, the research system is supposed to provide public goods, beyond the goals of individual actors, and public funding is provided to this aim; as shown by Science Policy Studies, political objectives might vary across countries and time. Second, the State keeps a central role in designing some basic rules of interaction: thus, the selection of the main organisation forms for public funding discussed in the previous section, as well as of the share of resources devoted to each channel, are still by large a political decision. However, the nature of this interaction is also shaped by the actors themselves and it is *endogenous* to the system, both concerning the number and type of players (the "market structure") and the broader institutional environment driving the behaviour of actors.

Thus, I conceive public research funding systems as sets of – partially overlapping and interdependent - interaction spaces between funders and performers, whose basic rules are defined by the State, but where the specific patterns of interaction are by large constructed by the actor's themselves.

2.2 Defining interaction spaces

Despite the complexity of funding systems and the wide differences among countries, comparative work shows that almost all schemes fall under few general organisational models (Millar and Senker 2000 Lepori et al. 2009). These allow the defining of the main interaction spaces which will be later examined, in terms of their "coordination modes" (Figure 2). Of course, this classification should be considered as an help to organize the discussion rather than an attempt to provide a coherent taxonomy: accordingly, the reader should be aware that variants and intermediary situations can occur in reality.

It is important to notice that the notion of interaction spaces implies that the relevant systems borders are not exogenously defined , grounding on legal or geographical distinctions, but they should be empirically derived from the observation of the stable and relevant patterns of interaction among actors. Thus, in the case of Space research, Europe can be considered as the relevant system's perimeter , given the central role of the European Space Agency and the close links among performers in different countries. However, in the aggregate of all domains and funding flows, the national level is still considered as the most relevant (as well as the most investigated) and this explains why the following discussion will be focused on it.

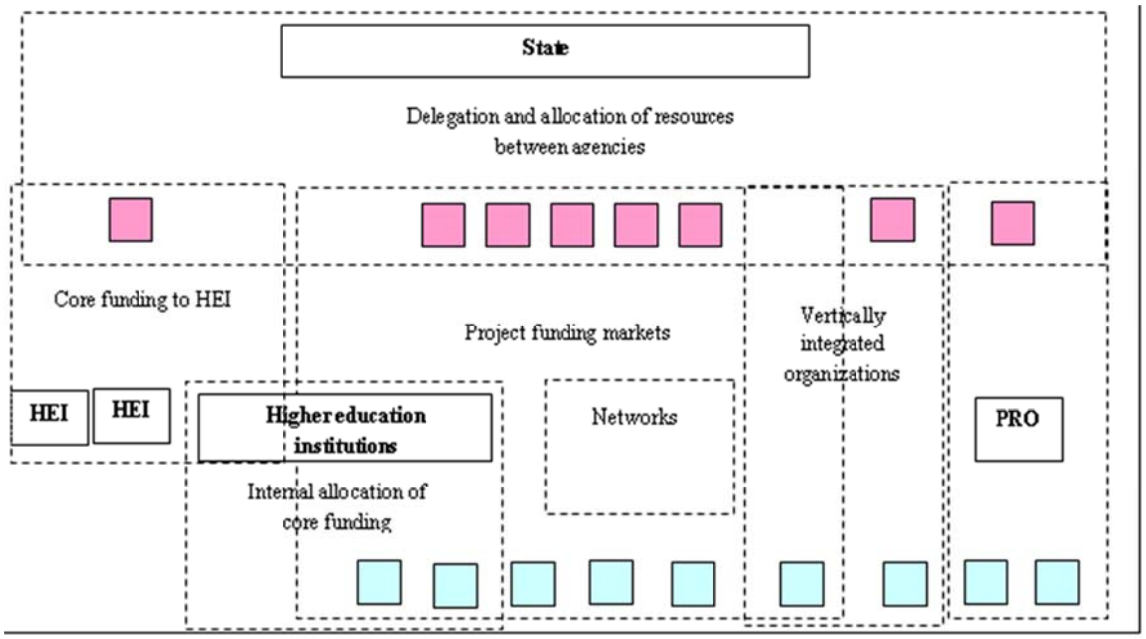

Figure 2. Interaction spaces in research funding

a) Project funding is directly allocated to a research group or an individual by a funding agency for research activities limited in time and scope. The State controls the repartition of funds between agencies and instruments - the definition of the portfolio – and to some extent the allocation criteria, while it has little control on the selection of beneficiaries. This mechanism creates an interaction space composed by a number of loosely coordinated funding agencies and a larger number of research groups applying for funding.

Network schemes – like the European Networks of Excellence – and project-based funding to centres of excellence – with a larger scale and a more long-term perspective - is usually considered in this category, but display specific features which justify considering them as a distinct mode of organisation.

b) Core funding to higher education institutions (HEIs), where the State allocates a global budget to HEIs for their normal functioning. Funds are attributed to ensure the existence of the organization and, in principle, is not limited in time. Usually, funding of HEIs is assumed by a single ministry at national level and thus there is potential competition among individual institutions, while there is a single funder; also, it is left to the steering body of the organization to decide how to internally allocate funds to individual units (earmarking might be present, but is typically limited to a low share of funding). This mode then creates a nested structure (Braun 2003), with the possibility of the competition both at the inter- and intra-organizational level.

c) Vertically integrated model, where an "umbrella organization" is delegated by the State and a global budget is attributed. This is allocated to internal units either as institutional funding or using competitive means. Two groups can here be distinguished: first, academic-oriented organisations, which in some countries constituted the bulk of academic research, like CNRS in France (Thèves et al. 2007), CSIC in Spain (Sanz Menéndez and Cruz-Castro 2003), Max-Planck Gesellschaft in Germany and the Academy of Sciences organisations in many Central and Eastern European countries before the transition; second, mission-oriented organizations focused on specific fields, like CEA and INRA in France and Fraunhofer in Germany. While for some aspects this mode resembles to core funding of HEIs, it shows also distinct features: thus, competition is not among umbrella organizations, being in many cases unique, but with other sectors and mechanisms, like funding of higher education. Moreover, the umbrella organization has a broader role than funding, as defining strategies, creating and dissolving units and setting rules for employment and internal careers; funding thus usually comes with internal evaluation mechanisms (Larédo 2008).

d) *Core funding to public research laboratories*. Examples are national facilities providing specific infrastructures (like supercomputing centres) applied research centres in domains of public interest (like agriculture) or public service organizations, for example testing materials or in metrology (see PREST 2002 for an overview of the European landscape and Bozeman and Crow 1990 for the US case). Unlike the former category, these are usually smaller organizations with a specific task, in most cases localised in a single place and which a specific link to a ministry or department (or funding agency) being their main funder.

3 Coordination modes and institutional arrangements

In this perspective, the main problem of research funding is how to achieve collective action to produce the envisaged outputs, in terms of new knowledge, economic innovation and contributions to society and culture.

Accordingly, agencies need to take into account the available capabilities before launching new funding schemes. At the same time, the strategies of research organisations and groups to develop their own capabilities need to *collectively* take into account the future orientation of research policy and availability of funds in order to avoid overcrowding in some areas and lack of competence in other areas. Further, actors' decisions crucially depend on expectations on the future behaviour of other actors: for example, funding agencies have to make assumptions on existing research capabilities, but also on the decision of performers to apply for their grants. Conversely, performers' decisions on developing research capability are largely built on expectations about future funding, but also about competition from other performers for the available schemes. The stability of these expectations is crucial for the functioning of the research system. Once a call has been launched the agency will be bound to distribute money among the received proposals and, if the applicants' behaviour does not meet expectations, agency goals will not be reached. Conversely, if performers' expectations on available funding are not met, investments on new research capabilities might not produce the expected effects. This drives to consider that signalling and information exchange about future strategies and behaviour plays a central role in actors' coordination (White 2002).

In the economic literature, this is a problem of *actors' coordination*, namely how to organise collective action in a world where individual actors enjoy considerable freedom of choice and where they can to some extent pursue their individual goals, while at the same time the production of social goods depends on the cooperation among actors. In neo-classical economics, this problem is solved through the market mechanism and it can be shown that under these conditions a social optimum is reached; from this departure point, a substantial body of literature has looked to market failures and discussed reasons why other means of coordination can be in some contexts more efficient (Williamson 1985).

At a broader level, institutional theory has demonstrated the importance of institutions – i.e. systems of norms, values and beliefs shared by the actors – to constrain and shape individual choices and to produce regularities in the aggregate actors' behaviour despite individual variance in individual choices (Scott 2001). Here, the approaches focusing on the individual actor as the elemental system component, trying at the same time to understand how embeddedness in institutional environments constraint and shapes actors' behaviour to produce collective action; relevant streams of literature include neoinstitutional economics (Williamson 1985), rational choice theory in political sciences (Moe 1984) and agency theory in social sciences (Braun and Guston 2003). Most of these works embraced an exogenous view of institutions –as the set of explicit norms or rules limiting individual actor's choices (North 1990). A broader view of institutions has been endorsed by approaches like socio-economics (Hollingsworth et al. 2002) and comparative institutional analysis (Aoki 2001) embracing the cognitive turn of neoinstitutional theories (DiMaggio and Powell 1991): they consider that institutions are to a large extent endogenous to the system and (collectively) shaped by actors' behaviour and,thus, that collective action can be sustained by a set of shared beliefs and actors relationships without being necessarily expressed in formal rules.

These approaches open then the way to a wider range of coordination arrangements beyond the classical dichotomy between markets and hierarchies (Williamson 1975); examples are clans for less formal organizations where cooperation is ensured through shared goals and beliefs (Ouchi 1980) or institutionalised markets (White 2002). At the

level of social arrangements – covering societies or economic sectors -, a number of institutional arrangements have been distinguished focusing on their underlying coordination principle (Hollingsworth et al. 2002):

- *markets*, where coordination is handled through the set-up of prices and exchange contracts, which convey all the required information.
- *private hierarchies* (firms), where coordination is handled through internal rule systems and hierarchical authority.
- *clans* or *communities*, where coordination is based on a set of shared values and goals internalized by the community members.
- *public hierarchies* (State) coordinating through public rule systems, for example laws, as well as their control and enforcement (for example bureaucratic arrangements).
- *networks* of actors, based on semi-formal membership and rules, which rely on a mix of self-interest and social obligations, and *associations*, where memberships and rules are stronger formalised.

3.1 Coordination modes, system's performance and institutional embeddedness

Coordination modes can be considered as prototypical ways of organizing social action in a world where there is no overall mind (very much like proto-institutions in comparative institutional analysis; Aoki 2001). In most cases, these mechanisms do not exist as alternatives, but *combinations of them are adopted to achieve actors' coordination*: thus, economic markets for quality goods are based on a combination of social relationships and price (institutionalised markets; White 2002), while many forms have emerged between hierarchical companies and communities, like private liability firms associations, as well as between corporate hierarchies and market arrangements (Milgrom and Roberts 1988). Also, top-down public bureaucracies have been replaced by more flexible structures through delegation to largely autonomous agencies (Braun and Gilardi 2006), while State regulation can be achieved through a mix of direct control and (quasi-)market mechanisms.

At a societal level, in most cases no single institutional arrangement is likely to provide a suitable solution to the coordination problem: the case for institutional diversity is based on the observation that all institutional arrangements display some weaknesses, but also on the fact that uniform institutional systems do not provide enough flexibility and dispose of a sufficiently rich repertoire of solutions to new issues and external pressures (Hollingsworth et al. 2002). This is typically the case in social domains like technology and research where innovation is central for long-term performance.

In this perspective, the critical issue is not the selection of the best coordination mode, but how to build on the complementarities and strengths of the different modes to develop institutional arrangements fitting the characteristics of the production system for research, by (Amable 1999). This analysis should then allow identifying which combinations of coordination modes are adopted in public research funding and which are their strengths and weaknesses, as well as their complementarities and their impact on the system-level performance.

Thus, a wide body of literature has demonstrated that the functioning of domain-specific arrangements critically depends on their embedding in a broader institutional context (Hollingsworth et al. 2002), a well-known issue also in Research Policy Studies (Elzinga and Jamison 1995; Senker et al. 1999); this includes regulations concerning property, markets, etc., as well as, in the public sector, the configuration of the political system, but also more fundamental and deeply-rooted values and habits. For instance, specificities of Japanese firms have been to a large extent related to the collective and cooperative culture of Japanese society against the more competition-oriented culture of the American society (Whitley et al. 1992). This approach could open some new perspectives on the lasting issue of explaining differences among countries in research funding systems, as well as understanding to which extent these policies need to take into account national specificities.

Further, the economic literature has explored the conditions under which coordination modes can function and it has evaluated them against different criteria. In economic analysis, efficiency is considered as the main criterion –to produce the requested good at the lowest possible cost. Transaction Costs Economics focused also on the information requirements of economic coordination, as well as on feasibility and costs of control. In the public domain, further relevant criteria are the ability to produce public goods, positive or negative externalities and equity conditions – with public money there cannot be discriminating decisions, for example choosing a supplier based on friendship.

For instance, the market can be considered as an efficient coordination mechanism if performance can be unambiguously measured; under these conditions, not only markets put low information and control requirements, but they can also tolerate a low level of socially shared rules and goals. Hierarchical structures are more robust against low ability to measure output, but they require some understanding of the production technology, so that by controlling employees behaviour hierarchy can control for the aggregate output of the organization; control costs can however be high and limit the performance and the size of the organisation. Clans and communities perform well where the transformation process is uncertain and outputs difficult to measure, but they require a strong socialisation mechanism, especially to integrate new entrants in the community (Ouchi 1980).

Looking at funding systems, efficiency is clearly a relevant criterion, with a strong focus on quality of products (outputs) rather than on quantity; the public good criterion refers to the ability to answer to social and political goals and

to respond to societal requests. Information costs and implementation issues are also a relevant issue as developed in the principal-agent approach, as well as equity and non-discrimination in the formal sense, as developed by most approaches to public bureaucracies.

A further relevant criterion refers to the ability of the research system to innovate, for example by quickly moving towards emerging sectors, promoting new ideas and approaches and answering to new social and economic challenges (Radosevic and Lepori 2009); dynamic efficiency can be related to the ability of rapidly shifting resources, to support emerging ideas and risky research and, finally, to keep a sufficient diversity in the research system as a repertoire of potential solutions to emerging problems.

4 Coordination modes in public funding: a conceptual framework

To develop this program it is necessary to investigate more in-depth the relationship between organisational forms of funding and coordination modes, beyond metaphoric associations like considering project funding as a case of market or universities as companies. To this aim, it is here started from the interaction spaces identified in section two , thus characterizing them in terms of their underlying coordination modes.

4.1 Institutionalised markets: project funding

Project funding has been mostly examined in terms of delegation, by using principal-agent theory to interpret the (bilateral) relationship between the state and research performers or the (trilateral) relationship between the state, intermediary agencies and performers (Braun and Guston 2003). However, the interactions among multiple agencies from one side, and laboratories which are autonomous agents to the other side, can be conceptualized as a market, where actors' coordination is mostly handled through contractual arrangements based on the price set for a given service or production; for research, the deal is with quasi-markets (Teixeira et al. 2004) since the purchased goods are not for the own-interest of the buyer, but for the general public interest.

In this setting, funding agencies select the performer which best meets their goals, while performers decide where to apply for funding and strategically develop their competences, depending on the available sources of funds. It is here noticed that competition essentially takes place concerning *quality*, while the price is in most cases more or less fixed; research groups need to decide if it is reasonably feasible to achieve the required level of quality and if its cost – for example for hiring people, developing infrastructures, writing a proposal - is worth the price (depending on the other options available and on the perceived position of potential competitors).

In the case of research funding, markets face two main problems in terms of efficiency: first, research quality is difficult to evaluate and, second, it has to be done *ex-ante* when evaluating proposals, while there is a risk that the promise is not met and that the performer, once received the grant, pursues its goals (shirking; van der Meulen 1998).

A sequence of short-term contracts – limiting the duration of grants to 2-3 years - is a promising approach under this condition (Fudenberg et al. 1990), which however increases implementation costs: shirking is less likely if researchers expect to get many grants from the same agency and if the following proposals are evaluated on the basis of the outcomes of the previous grants. Long-term schemes, where the pool of potential applicants is reasonably stable, are likely to perform better than one-time programs and fragmentation of funding agencies , as well as programs supporting the same type of research is likely to increase the risk of opportunistic behaviour.

Measurement of quality is also an important issue to be highlighted: a shared definition of quality and socially accepted procedures for its measurement are a prerequisite for a functioning project funding market; this is easier if funders and performers share some basic values, but shared conceptions of quality can also be constructed through repeated interaction in a long-term process; moreover, the traded goods need to be sufficiently homogeneous to compare proposals, a well-know issue for research councils which tend to segment competition according to scientific fields.

From the performer's perspective, a central issue is the ability to predict the level of required quality in order to get funded, since the building of capabilities is a long-term and risky process; this depends on stability and signals from funding agencies, but also the ability of evaluating potential competitors and their future strategies, the literature suggesting that there are informational and cognitive limits to the number of players a quality market can accommodate (White 2002). A multiplication of funding instruments when the size of the system increases and the type of research services differentiates can be foreseen: this is a well-known phenomenon in many countries (Lepori et al. 2007).

Also, project funding performs well under a moderate degree of competition: since usually the funding volume for each instrument is defined in advance, low competition means that performers might have incentives to collude, while high oversubscription rates make selection difficult, since review of project proposals is only able to discard the low-level proposals (Van den Besselaar and Leydesdorff 2009), bidders will then be confronted to an unpredictable situation (lottery effect) which does not allow them developing a long-term strategy . Accordingly, selection will be increasingly based on past performance, thus reducing room for funding innovative proposals and for new entrants.

This organisational form is likely to function well for small-scale markets, where the number of players is limited, the type of research activities (the traded goods) is sufficiently homogeneous and there are strong social ties and shared values among players, either because they belong to the same community (like in discipline-based subject communities) or to the same geographical region or to a specific domain (like space research). Conversely, social ties and repeated

interactions can be expected as tending to identify a rather small circle of grant recipients with a reasonable success rate alongside a larger circle of outliers, an hypothesis confirmed by some available data (Viner et al. 2006). In this context, the balance between market and community coordination – including barriers to entry based on social control - is delicate; project funding markets cannot function without shared values and strong social ties, but at the same time there is a risk that these lead to the creation of closed clubs and a repartition of funds based on social relationships rather than on quality. This is more likely to occur in small-scale markets with strong ties between funding agencies and performers.

Accordingly, a dynamic efficiency perspective points to the need of keeping a sufficient number of players, as well as reasonably low barriers to entry, in order to allow the emergence of innovation; this will be easier if the size of the market is large compared to the typical size of the performers and/or if there are complementary arrangements allowing new players to emerge and to get the required reputation. Small countries, where most scientific domains are very small, very specialised fields and big science, like nuclear energy or space, will thus be particularly confronted with this issue.

4.2 Associations, consortia and networks

While associations, consortia and networks are a widespread coordination mode of research, allowing to build more transient and light structures than formal organizations and to bridge different types of organisations, the use of these modes to allocate public research funding, defined as network delegation (Braun 2003) seems here to be at stake. In these schemes, the State attributes funds to a network or a consortium, leaving to the internal decision-making process the allocation among partners. Examples are national of excellence schemes, like the Swiss National Centre of Competence in Research (Braun and Benninghoff 2003) and the European Networks of Excellence (Luukkonen et al. 2006).

There are some reasons why this form can better coordinate actors in specific areas than funding agencies. The decision to fund a network defines a closed partnership (possibly with access rules) structuring internal competition; this implies stronger identification and self-interest to act collectively and to strengthen the network; moreover, this form allows for stronger (personal and organisational) ties between funders and performers than in funding agencies, where there is need for distinction of roles to ensure a fair selection. The involvement of external stakeholders in the decision-making process might be a further reason (Klerkx and Leeuwis 2008). Involvement of users and performers makes networks a stronger coordination tool than research programs managed by funding agencies, where individual projects have a tendency to become independent and incentives to collaboration are weak.

These features translate however in a number of limitations, since networks cannot be too large in terms of number of participants and of funding volume and since they are dependent on changes in policies which might undermine the self-interest of participants (for example creating competition for alternative funding sources); moreover, for equity reasons, it would be difficult to justify on a long-term basis a closed network distributing public funding and thus there is a tendency to consider public support to them as transient, unless they evolve towards a funding agency model. Networks will then require suitable entry mechanisms to associate new partners in order to be lasting. However, networks can have wider effects if they lead to a durable structuring of the actors' space which leverages also the allocation of project funds.

In public research funding, networks should then be mostly considered as transient means to structure the interaction space in situations where there are too many potential participants or where cultures and social values are very different (for example in domains where participation of stakeholders is highly relevant).

4.3 Regulated markets and private hierarchies: core funding to higher education institutions

Higher Education Studies argued how higher education steering and funding moved from direct public regulation – a public hierarchy coordination as discussed in the next section– towards (regulated) markets which leave more autonomy to individual organizations and which create also competition (Teixeira et al. 2004). In terms of coordination, this development can be interpreted as a shift from public hierarchies based on academic values (the French system being an exemplary case (Musselin 2001) towards a nested structure combining quasi-markets and private hierarchies for the internal allocation of funding.

While project funding is mostly characterised by a differentiated market structure, higher education markets are monopsonists, with a single buyer (the State or a delegated agency) alongside a usually large number of rather homogeneous service providers (higher education institutions), which deliver bundles of products in research and education. Both the number of higher education institutions and product bundling do not require market segmentation and multiplication of specialised agencies (beyond the two-tier distinction in binary systems; Kyvik 2004).

Bundling of products makes the measure of output difficult since detailed evaluation and comparison among different HEIs is difficult. In most cases, allocation is based on a few indicators - numbers of PhDs, publications, impact factors - , aggregating the performance of whole organizations with all kind of methodological difficulties and which can at best provide some measure of the volume of output and to very limited extent of its quality. Moreover, in most countries, alongside a performance-based component, HEIs receive a basic level of funds on the basis of their membership to this category (possibly different between universities and non-university HEIs). Thus, in terms of allocation's efficiency,

this mechanism seems to fare less well than project funding, especially if differences in research quality among individual HEIs are rather large. However, implementation costs are lower than for project funding since allocation does not require the set-up of specialised agencies and proposal evaluation processes. More precise measures entail high implementation costs, as demonstrated by the UK research assessment exercise (Barker 2001).

However, monopsonist power offers a more direct way to enforce public policy goals beyond the quality of research by creating strong incentives to performers behaviour (Geuna 2001), also concerning policy goals which are not shared by performers, like improving the internal efficiency of higher education by keeping a regional balance in the provision of higher education or by promoting synergies between research and education. While project funding markets tend to be highly institutionalised through shared norms and social ties around the notion of research quality, higher education markets are strongly regulated by the State and by large conceived as a tool for steering of higher education. This might explain the increasing relevance of this mechanism with the broadening and diversification of the higher education system beyond its academic core.

The key-feature of this mechanism lies in the use of internal hierarchy to allocate resources to research groups instead of letting them compete on the project funding market; if granted enough autonomy, higher education institution are able to perform this task and to respond to market incentives (Jongbloed 2007); however, the large degree of autonomy of academics, the impossibility of detailed control of work and the presence of tenured positions will tend to make these incentives as less effective, if they are not supported by shared values and strong internal social control. Moreover, HEIs rely to a large extent upon disciplinary culture for the evaluation of the quality (for example to appoint professors; these underlying community structures are likely to limit their responsiveness to external requests (Whitley and Glaser 2007). Work in organizational theory looking to the interpenetration of coordination principles (markets, hierarchies and communities) both in markets and in formal organizations offers a promising approach to analyse economic exchanges in so specific organizations as universities (Imai and Itami 1984; Milgrom and Roberts 1988).

Since allocation occurs among a closed pool of research units and since it has to be based on comparisons among groups in different domains, this mechanism fares less well than project funding on allocation's efficiency; at the same time, commitments inside organizations are usually more long-term (especially concerning tenured faculty) and HEIs are explicitly allowed to take decisions based on strategic considerations and on more long-term perspectives (this is not always the case for funding agencies). Especially in small-scale systems, where project funding markets would tend to be too small, reliance on HEIs can be considered as a suitable mechanism to keep diversity and to help new players to entry in project funding markets. At the same time, the ability of quickly moving resources towards new domains has to be questioned, given the slow and highly political character of internal decision-making processes in universities; one could argue that the need of core funding to be complemented with other mechanisms which are more responsive to new societal demands and developments in science.

Finally, for research groups it is likely to be less resources consuming to rely on direct negotiation with their host organization as the main source of funding, than on different funding agencies through proposal submission; this will be especially the case where project funding markets are weakly structured and thus the outcome of the selection process is difficult to predict.

4.4 Public hierarchies: the vertically integrated organization

A further form is the creation of a general-purpose public research organization channelling most of public funding in a specific domain. These organizations can be characterized as large public hierarchies, whose steering is delegated to representatives of the researchers themselves, through internally elected committees and where a strong identification either with academic values or with a specific organizational mission is the basis of individual's action. The French CNRS before the reforms of the last decades (Thèves et al. 2007) and the Academy of Science in Eastern European countries are relevant examples of this arrangement; in both cases, they managed the bulk of academic research, while higher education institutions were mainly devoted to education. In all these cases, membership to the community and internal careers, strictly controlled through entry selection mechanisms and peer evaluation provided access to financial resources mostly through permanent employment status. The Polish case, where the same organisational form for public funding has been maintained, but replacing the Academy of Sciences with a ministry, shows that without a common (academic) culture this setting cannot work properly (Jablecka and Lepori 2009).

This form – thanks to the combination between hierarchical organisation and shared values among the researchers themselves, but also to the structuring of the profession and internal careers -– should allow a strong central planning of research capacities at the level of the whole system, concerning also the choice of the priority research areas, as well as coordination avoiding their duplications. However, efficiency is bounded to the known limitations in the evaluation of the performance of laboratories, since by design there will be limited competition on the same subjects. Innovation at the organisational level, through the creation of new laboratories and the opening of new research areas, is also likely to be slow because of the length of planning cycles and of the limited freedom in resources allocation (mostly bound to permanent personnel); moreover, as the size of the organization grows, implementation costs – especially in time of the researchers involved in the decision-making committees – and the complexity of the decision-making process are likely to increase. The loss of importance of this model in most countries is likely to be related to changes in the organization

of sciences, where new search regimes depend more on building complementarities than on concentration of efforts (Bonaccorsi 2008).

The creation of internal quasi-markets for funding based on outcomes of the evaluation, increased reliance on project funding, as in the Spanish case (Sanz Menéndez and Cruz-Castro 2003) and building joint ventures with universities, as in the French case of CNRS (Thèves et al. 2007) are recent steps taken to overcome the rigidity of this allocation mechanism; to which extent this process is an adaptation or a result of changing the characteristics of these organisations has to be seen, as indicated by the lasting debate on the nature and role of CNRS.

4.5 Public hierarchies: the public research laboratory

A further example of public hierarchies are public research laboratories funded directly by a principal, like mission-oriented laboratories managed as branch offices of ministries directly producing the research services required to achieve policy goals, or national facilities managed by ministries or funding agencies to provide service to the whole scientific community.

This bilateral relationship allows the principal to define in detail the goals and services to be delivered, for example through contractual arrangements, and thus provides full control on research activities. A further advantage relies upon the ability of planning when facilities require long-term large investments.

However, this form copes with the difficulties of hierarchical steering under uncertainty and information asymmetry: while the research topic might be easier to control, the quality of performed research is more difficult without detailed assessment (requiring in the principal similar competences as the agent). Thus, this mode can be predicted as performing reasonably well for service activities and research which are directly of use by the principal for the implementation of its policies, but less for long-term research and where broader social outcomes are a major goal.

The shift from direct control to arm's-length control through incentives and performance contracts, as promoted by new public management (Bozeman and Crow 1990; PREST 2002), is relevant for a more efficient management and delegation of operational decisions, but does not fundamentally change the structure of the interaction when there is a single principal providing most of the resources and since the laboratory is unique. A more significant evolution is to push these organisations to compete on other markets and to diversify their sources of income: this evolution has been particularly strong for mission-oriented research organisations, which entered in the market for private R&D and services, but less for public project funding (most PRO's displaying a lower share of project funding than higher education institutions).

5 Nested structures, national configurations and dynamics

The previous discussion shows that requirements of actors' coordination limit the available options for the organisation of public funding and this might explain also why, despite national particularities, there are a limited number of organisational forms of public funding. Thus, vertically integrated organizations cannot be too large and they can cover only rather distinct domains, leading to vertical segmentation. The other available options are to segment the system according to the type of research product as in project funding markets or based on organisational (and mostly geographical) belonging of research groups to the same higher education institution; both of them give rise to nested structures. The issue of coordination becomes more complex and relevant for performance with the quantitative expansion, specialisation and differentiation of functions of current research systems.

A further remark is that all funding mechanisms discussed in the previous section require some level of shared values and social ties in order to satisfactorily function and thus can be considered as combinations of formal coordination mechanisms with community coordination. This is expected given the specific characteristics of research, where the measure of output is difficult, production technology is unclear and relationships between tasks and results ambiguous (Musselin 2007). It is here noticed that, since the deal is with the allocation of public funding, community coordination alone would be hardly acceptable even if, in some cases, the real practice might come very close to it.

However, different mechanisms depend on different types of communities and shared values and this is likely to influence the conditions under which they can work; thus project funding markets can be based on disciplinary communities, but also on communities sharing the same research topics and having a long term commitment for developing a research area (including also users and other stakeholders); these tend to be highly specific and can be highly adaptable and likely to emerge if demand for specific services is created. On the contrary, vertically integrated organizations need strong communitarian values among all their members as they can be generated by professional bureaucracies with formalised training and access rules and this is likely to make them less adaptive to changing external demands (as problems to cope with interdisciplinary fields might indicate).

Table 1 summarizes the previous analysis by relating coordination modes and organizational forms of research funding and by providing a view of their strengths and weaknesses.

Funding mechanisms	Coordination modes	Strengths	Weaknesses

Project funding	(Institutionalised) markets	Tailored allocation of funds through review of individual proposals. Potentially an efficient allocation mode. Promotes competition and strategic behaviour of laboratories. Allows State to purchase public goods through dedicated programs and agencies.	Requires small-scale markets and moderated competitive pressure otherwise can become innovation averse. Institutionalised linkages between funding agencies and performers and some level of shared values needed. Tends to promote strong concentration and thus there might be an issue of keeping diversity (especially in small systems) and low entry barriers. Implementation costs are rather high because of proposal submission.
Core funding to higher education institutions	(Regulated) market + private hierarchies	Allows direct State steering of organisational behaviour through incentives. Low implementation costs of allocation. Allows more long-term commitments and strategic planning.	Allocation is related to average quality of research teams, unless detailed assessment (with high implementation costs), thus allocative efficiency lower. Limited responsiveness to new demands and emerging research areas.
Vertically integrated PROs	Public hierarchies	Planning and coordination through public hierarchy and shared academic values. Concentration of resources in predefined fields.	Innovation becomes difficult at the organisational level (while it might be possible at the individual level). Control and measurement of performance are difficult. Implementation costs high especially if the organisation grows large.
Core funding to public laboratories	Public hierarchies	Allows close steering and definition in detail of research services. Scale economies and long-term planning become possible.	Control and measurement of performance are difficult, except for the more applied activities. Allocation efficiency low since there is no competition.
Centres of excellence and network schemes	Network coordination	Coordinate research strategies of different organizations. Builds interfaces and structures the performer's space.	Can hardly be adopted for managing the bulk of public funding for organisational and equity reasons. Difficult to maintain in this form over long periods of time. Risks of closed groups and exclusion of newcomers.

Table 1. Coordination modes and organisational forms of funding

Since most national funding systems are composed by a combination of organizational forms, it is relevant to develop the preceding discussion to understand the characteristics and conditions of functioning of these combinations. Besides its interest for comparative analysis, the reader should consider this as an exemplifying approach which could be applied to other subsystems (for example to funding for specific fields or topics).

To begin with, it is here noticed that at system's level the three forms based on core funding are mutually exclusive and lead to vertical segmentation – a research group cannot belong at the same time to an HEI and to a vertically-integrated organisation, while all of them can be combined with project funding. Moreover, there is a strong argument about core funding organisational models which can fulfil their function only if they control the largest part of the resources to the research groups belonging to them (as a resource dependency perspective would predict; Pfeffer and Salancik 1978); for instance, to respond to external incentives, HEIs should have some control on their research groups and this will be unlikely if these get most of their funding from external sources. We thus expect that stable configurations are only those where the system is dominated by project funding or where core funding accounts for the largest part of funding, whereas project funding might play a complementary role. Empirical results showing a clear-cut distinction between the US system, with a share of project funding around 80%, and most continental European countries, with a share of project funding between 20 and 40%, support this conclusion (Lepori et al. 2007).

5.1 The project funding configuration

In this configuration, the State distributes funds to different agencies (including branch offices of ministries, research councils, technological agencies, etc.), with little mutual coordination and which finance through competitive grants research corresponding to their objectives. The state acts essentially as a buyer of research services; for each policy goal, there is a specific funding agency directly related to the policy domain. Diversity of largely uncoordinated funding agencies is thus the rule and there is limited scope for overall coordination of research policy and of steering the research system itself.

Of course, this model can leave room for a limited number of research activities directly funded by the State through contractual arrangements. Two typical cases can be foreseen: national facilities which are largely unique, and public laboratories with a direct service to public bodies, where getting exactly the type of services required is a priority (for example in a regional context).

In institutional terms, this model assumes that the market can be also an efficient means to coordinate the overall research system (and not only the small-scale project funding markets). In wider social terms, this reflects the assumption that becoming a leading research system will also trigger down to reach other social goal thanks to

economic growth. A key requirement is however that research performers enjoy sufficient autonomy to orient themselves to research services demand and not to pursue other goals, like education or regional policy goals. Strong institutional autonomy of performers and the social acceptance that research quality (as measured by proposal evaluation and performance) has to be the main goal of laboratories are thus prerequisites of this model.

Under these conditions, cumulative advantages leading to the concentration of research capacities in a limited number of players (with some segmentation by submarkets), and thus to the emergence of stable reputation hierarchies, can be expected. However, a parallel requirement would be the size of the system being sufficiently large to avoid building an oligopolistic system which would reduce competition and, especially, diversity, an outcome which has been demonstrated in the very small-scale Estonian system (Masso and Ukrainski 2009). Unsurprisingly, the largest integrated research system in the world, the American one, is the best case of this model and to which extent it could function satisfactory in smaller countries or in systems (like the European one) which are highly fragmented remains an open issue.

5.2 The HEI based configuration

In this configuration most of research funding is channelled through core funding to HEIs. As discussed in section four, this configuration can allow keeping more diversity in systems which are too small to allow a very differentiated project funding markets both on the performers and funder side (most medium-size European countries having few large funding agencies). Moreover, through core funding incentives can be set to directly pursue other policy goals, like promoting the integration between research and education, as well as some regional diffusion of research activities.

However, this configuration fares less well in terms both of allocation's and dynamic efficiency, since targeting the best groups overall will be more difficult and HEIs are likely to be less reactive than funding agencies in redistributing resources. Hence, core funding should be completed with a rather large share of project funding to selectively reward the best research groups and to more directly pursue research in specific fields. A further issue concerns the risk of fragmentation and duplications (because also of overlapping strategies of HEIs and funding agencies), since this configuration lacks the strong concentration forces of the project-funding configuration; the introduction of instruments based on network coordination – like networks of excellence – can be seen as attempt to address this issue.

It is here suggested that in rather small-scale and homogeneous higher education systems both issues will be less relevant: problems of allocation's efficiency will be less severe if HEIs have similar levels of research activities and share definitions of research quality, while network coordination would tend to function better in smaller systems. This happens in some middle-size highly developed European countries, like Netherlands, Norway, Finland and Switzerland. Interestingly, all of them possess binary higher education systems, thus effectively shielding the core of research universities from large number of students and separating academic from practice-oriented higher education (Kyvik 2004). In larger systems with greater differences among individual HEIs, this configuration is likely to require a more selective approach to research core funding, through a precise measurement of their research output; an alternative option would be to increase the share of project funding, but, as discussed before, there are structural limits to it (unless changing radically the overall organization of the research system). Reforms of research funding in the UK since the '80 are a clear case of both strategies.

5.3 The vertically integrated configuration and its variants

This model adopts a single large-purpose research organization as the main coordinating device. Of course, the system can comprise also other research organisation (especially mission-oriented like in the French case), as well some research activities in universities, but it is clear that in terms of volume, reputation and policy, the national organisation is the main actor in the research system.

This model characterised most Central and Eastern European countries under the communist regime and, to some extent, also France until the Seventies, with the dominance of the CNRS (as well as of some other large-mission oriented PRO's). It was thus typical of centralised systems with strong state planning. However, countries like Spain (CSIC), Italy (CNR) and, to a lesser extent Germany (MPG) adopted a similar approach.

In a broader meaning, this model can be seen as a way of avoiding some of the problems of the university-based model in systems where the average quality of university research was rather low and too different from institution to institution and where the introduction of a market-oriented approach (either for HEI or for project) was not acceptable or feasible.

In its pure form, this model has ceased to exist in developed countries after the breakdown of the communist regimes and with the fundamental changes in the organisation of public research in France (Mustar and Larédo 2002). As already discussed in section four, vertically integrated organization forms seem not well suited to the current organization of sciences and the quantitative expansion of the research systems increasingly puts their ability of coordinate research under strain.

However, different evolutionary variants emerged, thus including the specific setting of CNRS with its joint laboratories in universities (Thèves et al. 2007), pushing large PROs to diversify their funding base and to compete for competitive

funding, like in the case of the Spanish CSIC (Sanz Menéndez and Cruz-Castro 2003) and promoting a mixed system with large PROs alongside universities competing for project funding, like in the German case.

The extent to which these forms are stable or they will progressively evolve towards one of the former models, with a clear separation between funding agency function and performer's organisation function, it is still an open question.

5.4 Dynamics and change

Analyses of organizational forms based on general criteria, like efficiency, inevitably raise the question to which extent real systems converge towards the most efficient configuration(s). At the same time, like any other institutional arrangements, funding systems are the result of historical processes where a good deal of path-dependency is at work, and historical analyses show that funding systems by large change through the evolution of existing forms and the addition of new ones alongside, and thus resemble more to a collection of elements inherited from different periods than to coherent design (Benner and Sandström 2000; Lepori et al. 2007).

A thorough discussion of this issue goes beyond the scope of this paper. However, a few remarks are relevant. Firstly, the present approach was to identify the best possible configuration: coordination modes can be used as a tool to detect the strengths and weaknesses of different organizational forms, as well as their conditions of functioning; the fact that a specific configuration shows weaknesses does not imply that it will be modified, might it be because other goals are deemed important (for example regional balance is more important than efficiency) or because the configuration is stable and resisting to change.

Secondly, the approach is by large evolutionary and tends to suggests ways to improve existing configurations rather than to completely replace them; for instance, a possible evolution of core-funding based configurations is to integrate them with a share of project funding, while switching to a project-funding configuration is a revolutionary change which would require to modify the overall functioning of the research system. Evolutionary changes are well-documented in research policy and research funding, while revolutionary changes would be considered as more rare events.

Thirdly, in the current European context, evaluation and benchmarking of research policies are increasingly relevant and they tend to convey normative models of how these policies should be organised; especially in cases of breakdowns or reforms the importance of these models and the extent to which national systems which do not conform to them might be subject to pressure, should not be underestimated.

Fourthly, while path-dependency is certainly at work, the potential for change should not be disregarded in a long-term perspective; the French case shows that a series of evolutionary changes in the organization of CNRS not only led to a profound change of the whole research system and of its funding, but also to the point where a configuration change, transforming CNRS in a funding agency, was seriously debated (Thèves et al. 2007); also, in Poland the strongly centralised system was astonishingly stable after the breakdown of the communist regime, but a set of broader changes and external pressures led in the most recent years to start its reform towards a more decentralised model (Jablecka and Lepori 2009). The previous discussion suggests that, while variants and adaptations are by large possible, the requirement of coordination puts strong limitations to the variety of possible configurations and suggests at least those too far from the basic models are likely to be unstable in the long run.

6 Conclusions: towards a new empirical program on research funding

This paper highlights how a good conceptual tools to address relevant questions in research policy (like the understanding of the impact of funding systems on science, the development of criteria to compare national systems and the identification of the set of instruments best adapted to reach policy objectives) is given by a perspective which looks at the funding systems from their institutional arrangements, thus observing how these shape the relationships between funding agencies and research actors..

The main effort has been represented by the development of a framework, by blending theoretical insights from institutional economics with the knowledge of research funding systems as derived from a set of largely descriptive and policy-oriented studies. Hence, the discussion has been kept at a high level of generality and empirical validation of most of the arguments (also because of the lack of suitably designed empirical studies) have not been provided

In this final section, the relevance of this approach for research policy is highlighted, thus focusing on some relevant insights from the previous discussion and proposing directions for future empirical work. These arguments are developed by concentrating on three topics, namely the *evaluation of functionality* of research funding systems, the notion of *complementarity of funding instruments* and, finally, the concept of *institutional arrangements*.

a) A first, important issue for research policy is the evaluation of the extent to which funding instruments are able to achieve their objectives. The paper provides two contributions in this respect. First, it derives from the economic literature a coherent set of criteria against which evaluate the functionality of instruments (see section 3.1): these allow to systematically take into account conflicting goals and trade-offs, as between choosing the best performers in terms of research quality (efficiency) and answering to social needs (quality). The actor-centered approach highlights the

centrality of the *dynamic efficiency* criterion - i.e. the ability of quickly responding to new developments in science and to new societal requests – and its close relationships with the structure of the interaction field among actors.

Second, the paper provides directions on how to operationalize these criteria specific to the different coordination modes which characterize funding instruments, as well as first insights on their strengths and weaknesses; hence, it is here suggested to analyze dynamic efficiency in project funding through measures of diversity of grant recipients and entry rates of new recipients across time, while the same criterion could be analyzed in HEIs core funding by measuring diversity of research groups inside and across institutions and their demography (e.g. birth and death rates). Unlike many existing evaluation studies, these measures do not refer to the characteristics of instruments themselves– e.g. evaluation and allocation criteria, characteristics of the funding agency, procedures -, but to the characteristics of the interaction field and to the relationships between funders and performers.

The next step in an empirical agenda is then to the design of studies which empirically test these propositions by correlating the suggested measures of functionality with observed system's results, across different settings; e.g., this would imply to measure entry rates in project funding markets – across fields, instruments and countries – and to systematically relate them with measures of innovation, like the development of new research lines, by controlling at the same time for potential factors influencing this relationships.

b) Existing empirical evidence shows that most national research funding systems are composed by a patchwork of instruments introduced across time with an incremental logic, adding a new instrument when new requirements emerge, instead of restructuring the existing ones. This is coherent with the discussion on institutional complementarities: like other institutional arrangements, research funding systems need to answer at the same time to conflicting requirements and they are subjected to changing environments and new requests; hence, a strong argument which states that differentiated systems are, at least in the long run, more functional than those relying on few instruments.

In terms of policy analysis, the paper suggests that instead of trying to identify the best possible funding model and proposing far-reaching reforms, it would be preferable to identify weaknesses of the existing portfolio and to analyze how to overcome them through careful reforms of existing instruments and selective introduction of new ones. Some arguments presented in the paper – like the need of long-term development of research capabilities, the strongly institutionalized character of funding markets and the importance of trust and stable ties among actors – imply that the existence of stable institutions and expectations on the future is critical for the development of actors' strategies and thus make a case for a progressive rather than for a radical approach to funding system's reforms.

Moreover, the complementarity argument suggests to shift the focus from the working on new, individual instruments to understand their interaction with existing ones, as well as the strategic reactions of actors (both in the funding and performers layers) as related to their representation of the overall funding environment. E.g., this implies that design and impacts of new European-level instruments are likely to depend on the characteristics of national funding systems, like the availability of similar grants at the national level (e.g. in the case of the European Research Council).

The next step in an empirical agenda is then to design studies focusing on the interaction among different instruments rather than on individual ones. The most critical area in this respect is considered the investigation of the interaction between HEIs core funding and project funding *across the different layers*; this means examining how research groups strategically manage the two streams of funding, but also how these interactions are shaped at the level of HEIs themselves (e.g. through overheads and performance-based funding) and at the policy layer (e.g. in the repartition of resources between the two streams and in completion between funding agencies).

c) The discussion on configurations suggests that, from the perspective of actors' coordination, there are relatively few stable configurations of national funding systems and, at least heuristically, these largely match results of comparative analyses. For instance, core funding based systems are structurally different from project-funding systems and this leads to the prediction that national systems should clearly fall in either of the two categories; the paper provides also some arguments to explain widely diffused strategies to improve existing systems like the use of networks as funding instruments and bears some predictions on when this should be observed.

This approach allows developing propositions on strengths and weaknesses of overall configurations, as well as on the conditions under which funding systems can be expected to perform well; thus, the US project-funding configuration is largely based on the belief that best research will eventually provide also the solution to societal problems, but it this goal is likely to be achieved in large-scale systems, whereas in smaller systems other configurations could provide better results.

It is difficult to understate the relevance of these results for research policy analyses, since it becomes possible to understand in which directions existing configurations can be improved, which are the main alternatives and if recipes adopted in other countries are likely to work in national contexts and to match national political goals. For instance, in core funding based configurations with very low share of project funding, an increase of this share is an incremental improvement of the system, whereas if this share is already high this is likely to require a structural change of the whole configuration (and this might not be compatible with other objectives or institutional arrangements).

The next step in an empirical agenda is then to design studies analyzing national configurations of funding systems, by combining information on the structure linking actors in and across the different layers, on the overall structure of flows of research, and, finally, on the broader institutions underpinning their functioning and to use this information to provide a mapping of the main interaction spaces characterizing national funding systems, of their structure, relative importance and interactions. For instance, project funding markets could be addressed through a combination of data on the allocation of funding and changing markets shares by participants, complemented with more qualitative information on shared social norms and values - as revealed by actor's behaviour -, as well on social linkages among actors through techniques of social network analysis.

This would firstly provide a richer picture of national funding systems and, secondly, a ground for systematic and theory-based comparisons among countries, beyond the simple description of portfolios of funding instruments.

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