Paper ID: A098

Additionality effects of a Science-Technology policy: its contribution to the articulation of a Sectoral System of Innovation

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Keywords: Evaluation, Articulation of Innovation System, Additionality, R&D Public Policy.

Abstract: This article discusses the results of an evaluation of the Spanish Food Technology Programme (1988-2000). In particular it raises the additionality analysis of an R&D policy according to the increase in the agents' activity and in the number of relationships among them. Therefore, the goal of the article is to study whether a policy promoting R&D activities in the area of Food Technology (the Spanish Food Technology Programme (SFTP) which is part of the National R&D Plan) has contributed to improve the articulation of the Spanish Food Innovation System.

We analyse the participation of the Spanish Scientific Research Council (CSIC) in the Programme and highlight the role of "Interface Structures" to facilitate the cooperation between research groups and food industry firms. We conclude that, in addition to the relationship tools that Spanish Food Technology Programme established, it is also necessary to develop Interface Structures. As a consequence the desired articulation of the Spanish Food Innovation System is still far from being achieved. Therefore the additionality effect of this policy is scarce in terms of input-output analysis and even null in terms of behavioural additionality.

Introduction

Science and Technology policies are a relatively new issue in Spain. Even though it has passed quite a lot of time since they were fully institutionalised so as to analyse their role and influence on the Innovation System under a temporary perspective. According to a structuralist-evolutionary theoretical approach (Lipsey and Carlaw, 1998; Metcalfe and Georghiou, 1998; Metcalfe, 2002), such polices respond to the need of strengthening the role of the Innovation System's agents, in order to make easier the achievement of both direct and indirect results (David et al., 1995; Buisseret, et al., 1995; Luukkonen, 2000 among others). It is possible to analyse this strengthening role under the light of the additionality idea. According to this idea, policies can be viewed as stimulus mechanisms to the agents' participation, which does not mean the substitution of any scientific-technological activity carried out by those agents on their own initiative (Luukkonen, 2000; Georghiou, 2002). That is, the policy role is to provide a solid ground, according to its own objectives, to carry out research and technological development activities in addition to those activities which agents

already might be carrying out under any other private support scheme. So policy is not considered a substitution but a complement of these activities.

Under this framework it is worth to analyse the articulation of the Innovation System, understood as the System's capacity to establish fluent and continuous knowledge flows among the agents, thus it is possible to promote joint learning (Fernández de Lucio et al., 2003). The interest of this analysis mainly rests on the possibility of strengthening the relationships among the agents due to the presence of a public policy. More specifically, R&D activities have been actively pushed in Spain since 1986 when the Law of Science was announced and the National R&D Plan was subsequently implemented. One of the objectives of the Plan was precisely to foster both R&D activities and relationships among research groups and firms using financial and structural tools.

This article raises the additionality analysis of an R&D policy according to the increase in the agents' activity and in the number of relationships among them. Therefore, the goal of the article is to study whether a policy promoting R&D activities in the area of Food Technology (the Spanish Food Technology Programme (SFTP) which is part of the National R&D Plan) has contributed to improve the articulation of the Spanish Food Innovation System and subsequently know whether this is the result of an "additionality effect".

In order to reach our goal in this paper we study two crucial areas of any public policy: on the one hand the role and influence of the financial tools used in this policy which mainly consist of direct financial support to research groups as well as financial support to foster collaboration among research groups and firms through joint R&D projects, (the so called *relationship tools*); and on the other, the analysis of managerial structures (*interface structures*) which can be considered as a policy structural tool on the research groups and firms service in order to foster relationships. Summarising, under this framework we analyse whether financial and structural tools have been the suitable mechanisms to promote the articulation of the Spanish Food Innovation System aimed at introducing innovations within such system.

The structure of the paper is as follows. First we show the theoretical background on additionality applied to our study and how to measure this concept related to policy intervention. In addition, we show the relationship between additionality of a policy and articulation of an innovation system as the core of the theoretical background. Second we introduce the policy's empirical background with respect to the financial and managerial tools used to apply such policy. Afterwards we analyse the data referred to the public financial support provided within the policy scheme as well as that of private origins to find out to what extent the results regarding the promotion of articulation in the Spanish Food Innovation System are due to additional effects of the public policy. Finally we draw some conclusions related to the additionality of this policy with respect to the promotion of articulation as the policy's objective.

Theoretical background: the articulation of the Innovation System as the additionality effect of a policy

The production of literature on additionality effects of R&D public policies is concentrated in the last two decades. It is basically related to the evaluation of European R&D programmes (Buisseret, et al, 1995; Luukkonen, 2000; Georghiou, 2002, among others) and is grounded on a Structuralist-Evolutionary policy context (Lipsey and Carlaw, 1998; Metcalfe, 2002). Under this approach the concept of additionality is used to measure to what extent public support for R&D activities makes a difference in stimulating new and private support for such activities.

Or alternatively, to what extent those activities would have not been carried out in the absence of such public support. This double view of the concept is usually named as input and output additionality (Georghiou, 2002) and is mainly addressed to the firm's participation in S&T activities. Furthermore, the concept evolved to introduce the possibility of changes in firm's behaviour after participating in such activities and as a result of policy intervention. That effect is the so-called behavioural additionality.

Several critics to this approach (Bach and Matt, 2002) have argued that it rests on three assumptions all of which would be challenged within a structuralist-evolutionary perspective:

- There is a clear link between input and output of innovation activities
- Divisibility and constant returns to scale of the innovative activity
- No difference in the nature of the output generated by public and private funding.

Other drawback could also be argued with respect to data availability to analyse and make operative this concept and apply it to policy evaluation. Hence, there is room for further research in this field. Firstly, the context of a nation-wide policy trying to affect a whole sectoral innovation system is much larger than that of firms receiving a subsidy: the nature of the agents participating in an innovation system is more heterogeneous, therefore the link between input and output of innovation activities is rather fuzzy. Secondly, the objective here analysed (promotion of the articulation of an innovation system) implies a behavioural change of both firms and research groups participating in joint activities funded from the policy, but also a change in the way of managing this policy to achieve such objective, therefore the idea of behavioural additionality could be amplified to embrace all the innovation system's agents participating in a policy.

In order to reach our goal we study two crucial areas of any public policy: on the one hand the role and influence of the financial tools used in this policy which mainly consist of direct financial support to research groups as well as financial support to foster collaboration among research groups and firms through joint R&D projects, (the so called *relationship tools*); and on the other, the analysis of managerial structures (*interface structures*) which can be considered as a policy structural tool on the research groups and firms service in order to foster relationships. Summarising, under this framework we are able to analyse whether financial and structural tools have been the suitable mechanisms to promote the articulation of the Spanish Food Innovation System aimed at introducing innovations within such system.

Within this context we consider that the goal of relationship tools is to increase R&D activity and promote relationships among the System's agents basically providing them with financial stimulus, whereas the role of structural tools is to "dynamise" the Innovations System agents (Castro et al., 2001) with respect to innovation topics as well as to facilitate and catalyse their relationships through different types of activities. Using an anatomical simile, we can say that the combination of relationship tools and interface structures act as the articulations of the human body, which favour displacement by facilitating movements (Fernández de Lucio et al., 2003).

Firstly we focus the analysis on the relevance and use of financial tools provided by the policy to foster R&D activities among the research groups and Spanish Food and Beverage Industry (SFBI). These tools are grouped into two different categories: the first one is addressed to provide direct financial support to research groups (R&D Projects) and the second one to articulate the Innovation System through joint collaboration of research groups and firms (the so called relationship tools: PETRI Actions and Concerted Projects). That way both categories of tools can be considered as an incentive to increase R&D activity. This, in the end will affect all formal relationships among these two types of agents and will have a

reflection on the number of total bilateral contracts signed between them, which are also included in the analysis.

These types of policies usually pursue the introduction of behavioural and cultural changes (relationships for innovation), therefore accurate management of the tools is key to achieve the objectives because at the beginning, agents do not know neither the new tools characteristics nor are used to their specificities. In addition, the lack of communication among research groups and firms is usually considered a challenging point and the reason why the tool may fail. Hence, the policy management carried out by the administration in charge of it also has to be considered as a key factor that feeds the additionality process, since its main role is to reduce distances between research groups and firms. Therefore, the management is analysed in two respects: first, the management carried out on the financial tools and second, the management carried out by the interface structures on the research groups participating in R&D activities jointly with firms of the SFBI.

Empirical Background

1. The role of the Spanish R&D Plan in the promotion of relationships within the Innovation System

The Spanish R&D Plan aims at supporting the scientific community to enable them to undertake R&D activities within a common framework provided by the Government. Since this plan was launched in 1988 it has become evident the need to evaluate its performance in order to assess whether and up to what extent the original objectives have been achieved and whether those objective would also have been achieved in the absence of the plan.

One of the Plan's objectives was *the promotion of relationships among the agents* participating in the R&D Plan, that is, among research groups (from the university and other public research institutions), technology institutes and firms). This concern appeared again in one of the programmes included in the R&D Plan, the Spanish Food Technology Programme (SFTP) which was part of the Spanish R&D Plan from the very beginning. However, this Programme, like the rest of the Plan, attempted to cover all the stages of R&D thus widening potential participation to a wide variety of agents (firms, technology institutes and public research institutions), as well as fostering co-operation among them. The initial Programme's budget estimated in 1988 amounted to approximately €45 million. The highest share of this budget was earmarked for the creation of technology institutes in the Food Technology area (€14.7 million, 33% of the total budget) and the support to R&D activities through different financial tools (€12 million, 26.7% of total budget). Therefore, almost 60% of the total Programme's budget was address to directly or indirectly foster the System's articulation. This figure makes evident the administration's concern with respect to the promotion of the System's articulation.

In order to foster relationships among the agents, as well as the creation of an appropriate technology environment for the Food Industry, the SFTP had envisaged measures to favour the joint participation or research groups and firms in R&D and knowledge transfer projects. Among the first groups of measures it was the definition of the three types of financial tools to promote the participation of the agents in R&D activities: R&D Projects, PETRI Actions and Concerted Projects, being these two last types what we have previously named *Relationship Tools*. The first type is only addressed to provide financial support to research groups from universities, other public research institutions and technology institutes aimed at undertaking applied research projects. PETRI Actions are addressed to research groups from public research institutions in collaboration with firms to finance knowledge and research

results transfer projects. Finally, Concerted Projects are addressed to firms and consist of loans with a low interest rate to finance technology development projects in collaboration with, at least, one public research institution. These three tools constitute the core of the SFTP tools addressed to financially support R&D activities in the food technology area. According to the aim of each of these tools it is possible to depict a linear innovation process model of consecutive phases starting from the scientific realm. We cannot forget that the results from TEP (OECD, 1992) were published four years after the SFTP was launched and this publication meant the OECD countries' adaptation of the innovation process model from a linear approach to an interactive one.

In addition, it was envisaged the creation of a technology environment able to solve the specific needs of the Spanish Food and Beverage Industry. In order to tackle this problem the administration might foster the creation of sectoral associations and technology institutes in specific areas of interest within the Spanish food industry. These institutes and associations counted on the initial support of the administration until they could operate autonomously after being endowed with infrastructures. From that point onwards, firms in the area might charge with 100% of operating costs.

With respect to the Spanish Food Industry we need to show some characteristics which made evident the need for the creation of technology institutes in order to increase their new knowledge generation capacity. This sector is made up of less than 6,000 firms, basically small and medium sized ones (97% of them with less than 250 employees) and only 26% of them declare to carry out technology innovation activities and only 6% to carry out R&D activities. R&D personnel rises to 1,200 people (in FTE units) and only 500 are researchers, having obtained the PhD degree just 80 of them. All this personnel is concentrated in 70 firms with more than 250 employees (62% of personnel and researchers) (INE, 2003). This is the reflection of the sector's dichotomyc structure: few large firms and a large number of micro and SME. If we analyse the innovation strategy within this sector we can realise than the percentage of innovation expenditure devoted to R&D activities is less than 25% and the percentage of contracted R&D is around 3%. This entrepreneurial profile makes very difficult the relationships with the scientific environment because R&D activities are not part of their usual activities and the lack of adequate training implies a low absorptive capacity (Cohen and Levinthal, 1990). The innovation survey reflects these characteristics: less than 2% of SME in this sector and 17% of large firms co-operate with universities and other research institutions (INE, 2004).

Summarising, the structural objective of promoting the articulation of the Spanish Food Innovation System rested on two measures. On the one hand on the role of the financial support provided by the three types of tools designed for the SFTP: the R&D Projects and the two types or relationship tools; and on the other, on the administration conviction power to promote the creation of an actual technology environment involving the Food Industry in its maintenance and further growth.

2. The Role of the Management structure on the SFTP's implementation: central administration and Interface Structures

One of the main aspects to take into account in the analysis of relationships is the management of the tools used to promote them. With respect to what the Programme's management has meant, it is worth to mention that it is the first time that the Spanish administration devotes a large amount of money to support R&D activities with the creation of the Spanish R&D Plan. The responsible management body for the R&D Plan mechanisms and their coordination was the General Secretariat of the Spanish R&D Plan, which depended

on the Interministerial Science and Technology Commission (CICYT) which had only a small administrative staff and some prestigious researchers on a part-time basis temporarily transferred from public research institutions. Therefore, the management of the R&D Plan has never counted on a group of experts for each area who could devote time and efforts to really know the characteristics of the research groups, their actual needs and possibilities in order to make a proactive management of the Programmes. Under these circumstances, regardless the manager's capacity, the management of the Programme was passive, just trying to fairly distribute the money assigned to the area among the different proposals submitted by the research groups, the scientific interest being the most important criteria to make such distribution.

Technical management of each tool was transferred to three different offices. This fact in itself reflects the lack of flexibility in the management at the time of evaluating project proposals sent by the same research group to different tools. We cannot forget that the larger the bureaucracy needed to submit a proposal the lower the incentives or research groups and firms to carry out activities in collaboration. This fact should make us think about the possibility that many research proposals might have ended up as bilateral contracts just to basically avoid a long and bureaucratic process. Regarding the accepted proposals of R&D Projects, their management was given to a department of the General Secretariat of the R&D Plan. Another department of the General Secretariat with different people, also with the support of very few administrative staff, managed the PETRI Actions (one of the two relationship tools) for all the Programmes of the Spanish R&D Plan. Hence, these actions mainly arising from research groups were managed in a passive fashion with only a weak coordination with the rest of the programmes. We can characterise this management style as horizontal regarding the type of tool but not the scientific area or Programmes of the R&D Plan. This reflects the lack of human resources to carry out this activity.

Finally, the Centre for Technological and Industrial Development (CDTI), belonging to a different Ministry, managed the Concerted Projects (the other relationship tool which was leaded by a firm). These projects emerged as a response to the demand of the Food Industry for scientific support from research groups. But the management of the tool was carried out without any coordination with the other departments of the General Secretariat of the Spanish R&D Plan. Just a previous report sent by this Secretariat to analyse the relationship but not to technically evaluate it, was the only coordination mechanism.

That is the whole picture of the management carried out by the central administration, but we want to highlight that the specific management of the proposals submitted by research groups from public research institutions has been carried out from the Interface Structures located within these institutions. This set of offices constitute the Research Results Transfer Offices network (OTRI), created in 1989 and one of their tasks is to provide technical assistance to the research groups to prepare and submit project proposals to the SFTP's relationship tools (PETRI Actions and Concerted Projects). Basically the role of these interface structures with respect to this task is to avoid research groups the learning process associated to the use and applicability of any financial tool. Therefore, since they were created, the interface structures have actively participated in the creation and shape of the Spanish Innovation System as the organisations promoting relationships between the research groups which are the objective of their efforts and agents from the financial, technology and production environments closer to them.

In general terms and according to Fernández de Lucio and Conesa (1996), the interface structures can be defined as units established within one environment boundary (scientific, production, technology or financial) and its area of influence to dynamise the agents of such environment with respect to innovation topics and to foster and catalyse relationships among

them. Among the different types of Interface Structures, OTRI are the most common type among the agents of the scientific environment. They rose mainly in 1989 from an initiative pursued from the Interministerial Science and Technology Commission (CICYT) which decided to promote with an active policy the relationships among agents of the Spanish Innovation System. From that point on, many universities and a large part of Public Research Institutions decided to create an OTRI within its boundaries. Main differences can be found in the type of assigned tasks. Some of them understood the reasons to create them, following Lipsey and Carlaw (1998) idea of a type of elements that might contribute to establish relationships among researchers and firms. Therefore, those OTRI were entitled to foster and contribute to this task. In other cases, OTRI were considered as managerial offices of the universities' R&D activities carried out by their research groups. Other countries have developed similar initiatives in this respect (Dill, 1995; Siegel, et al., 2003).

It is rather unlikely that we could now be talking about the promotion of relationships if these offices would have not been created. Actually, the Interface Structures were created to promote the same objectives as the SFTP tools. Therefore, the articulation capacity of them is complemented with the existence of the Interface Structures and vice versa. This fact is clearly shown in the case of the role carried out by specific OTRI such as those located in the University of Santiago, the Polytechnic Universities of Catalonia and Valencia and the University of Navarra. A former study where the PETRI Actions were evaluated (Modrego et al., 1999) the role of the OTRI was highly significant for the development of these actions and the tool itself (providing information to participants, submitting proposals, focusing the proposals, negotiating with the Spanish R&D Plan central administration) and carrying out other important tasks such as the search form firm partners, negotiation of cooperation agreements with firms, monitoring of PETRI Actions, but non of the surveyed firms and research groups considered that the OTRI's role was irrelevant or non significant.

Data and Methodology

The analysis of the articulation fostered by the SFTP has been performed on the basis of the Spanish Council of Scientific Research (CSIC) participation. It is the largest Spanish public research institution (with a research staff of 6.700 researchers, 8% of Spanish researchers in 2002 and a scientific production of 4.750 articles in international databases, around 16,5% of the Spanish total scientific production). The most important research institutes in the area of Food Technology belong to CSIC and they have actively participated in the SFTP (around 40% of total financial support was allocated among CSIC research groups).

In order to analyse the articulation fostered among the CSIC centres participating in the SFTP, a multivariate analysis is performed on the main variables complemented with some interviews with research groups leaders. Therefore we first have to bound the research groups of each institute participating in the SFTP according to their participation in R&D Projects and the information provided by each Institute's direction. The result is also shown in that table: there are 54 research groups in the 8 CSIC institutes participating in the Programme. However, we can realise that main participation is referred to four institutes in this area: IATA, IF, IFI and IG. These four institutes have participated in 137 activities within the SFTP out of 169 and have carried out 276 bilateral contracts out of 334 within the analysed period of time which runs from 1988 to 2000. This means that 81% of the SFTP activities and 83% of bilateral contracts have been carried out by these four institutes.

With regard to the variables used in the multivariate analysis we can group them into these four categories:

- Those characterising the research groups such as average size of research group in each type of tool, average age of research group, etc.
- Those characterising the output produced with the participation in R&D Projects: international articles published, doctoral theses produced, trained personnel and patent applications.
- Those characterising the participation in the three types of the SFTP tools (R&D Projects, PETRI Actions and Concerted Projects) in terms of their number and budget involved.
- And finally those characterising the contracted activity carried out by the groups measured in terms of number and budget for each type of contract (basically technology support and R&D contracts, which represent more than 90% of total number of contracts).

Using these variables we have performed a factor analysis in order to obtain new factors explaining the relationships of the research groups with food industry firms. We have used SPSS software to carry out the analysis. The factors obtained show how the original variables influence on their configuration according to the weight of the variable coefficients. The new factors will help explain the behaviour of research groups with regard to each tool: whether they combine the different types of tools in their research activity or just use one type solely. In the end these new factors will tell us about the role of the SFTP in the promotion of relationships.

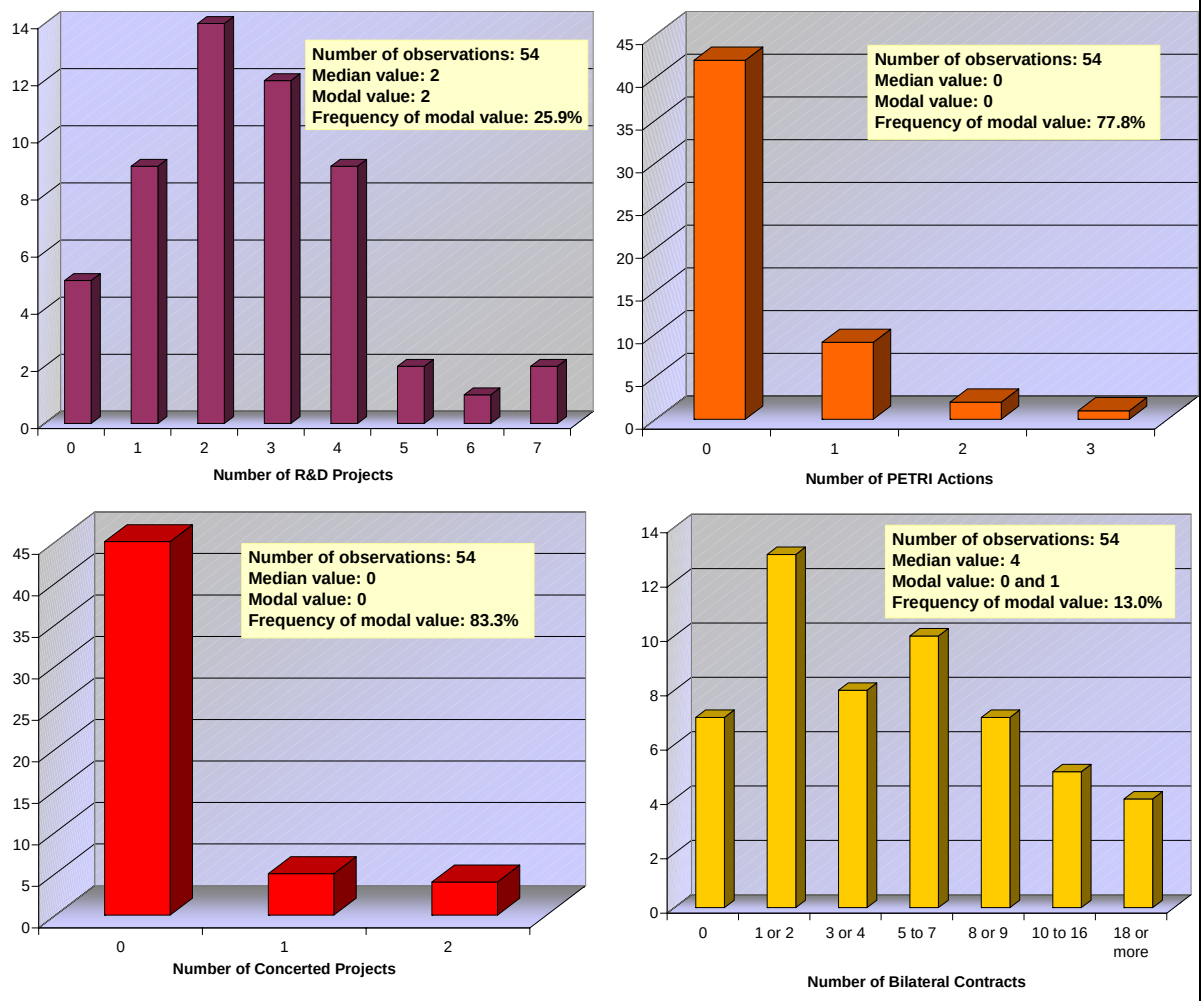
This factor analysis has been combined with a cluster analysis to check whether there are large differences in the behaviour of research groups in the use of the tools. Cluster analysis can help us to clearly distinguish these groups. The aim is to provide support to the idea of a differentiated management of groups and tools according to their characteristics and whether the policy has boosted the collaboration between research groups and firms due to the fact of an increasing number of bilateral contracts signed between them. This will also be supported by direct interviews with research group leaders.

Results: The articulation promoted on the Spanish Food Innovation System

The analysis of the CSIC research groups' participation in the SFTP's tools confirms the low acceptance of the relationship tools compared to R&D projects and bilateral contracts: research groups have participated in 139 R&D Projects, 17 PETRI Actions, 13 Concerted Projects and have signed 334 contracts with firms. Also from the histograms (Figure 1) we can observe that they specially devote their efforts to undertake R&D Projects and bilateral contracts. The median value is 2 for R&D Projects and 4 for bilateral contracts and the modal value for R&D Projects is again 2 projects, being 0 and 1 in the case of contracts. These indicators are, by large, 0 in the case of PETRI Actions and Concerted Projects the two SFTP tools created to promote relationships between research groups and food industry firms. Furthermore, and with respect to PETRI Actions, they do not appear until 1990 and are used in a random fashion for all the research groups with the exception of those belonging to the IG Institute. Since 1993 these groups have participated in 6 out of 14 PETRI Actions carried out within the CSIC, representing 43%. The previous year coincides with the creation of the CSIC's Technology Transfer Office where the IG is located what demonstrated the dynamising role of the office. We can also observe a smooth growth in the number of contracts along time, specially since 1994 when the central CSIC's Technology Transfer

Office started with the promotion of dynamising activities among the research groups and the incorporation of sectoral technical personnel to foster relationships with firms.

Figure 1. SFTP's tools and bilateral contracts histograms of CSIC research groups



Source: own ellaboration from CSIC data base

Three factor analyses have been performed. In the first one, we have considered variables representing the number of actions[1] carried out combining them with those representing research group characteristics and outputs generated with R&D Projects. Afterwards, we have carried out a second one considering those variables representing the financial support provided to each type of action combined with those representing the group's characteristics and scientific-technological outputs generated with R&D Projects. We have used the two sets of variables in the third one. The results from this third analysis are rather fuzzy so we will focus our explanations on the two firstly indicated.

The results form the analyses on the number of actions and the financial support provided to those actions seem to be very similar: in some cases analysis one provides an easier

[1] Actions refer to the different types of SFTP's tools and bilateral contracts.

interpretation for the factor, in other cases this interpretation is provided by the analysis two. Therefore we prefer to show the results of the two in parallel[2] (table 1) and compare them in our explanation of the factors. In the end we obtain a characterisation of the factors as new variables that will help explain the behaviour of the initial observations with regard to the use of the different SFTP tools and bilateral contracts and how the groups combine the use of the different types of actions in their research activity. For each factor the results of the first analysis are reflected in the first columns and those for the second analysis in the second columns with a smooth shadow.

TABLE 1. COEFFICIENT MATRIX OF ROTATED COMPONENTS*

	Factors*							
	1		2		3		4	
	Analysis 1	Analysis 2	Analysis 1	Analysis 2	Analysis 1	Analysis 2	Analysis 1	Analysis 2
Doctoral Theses	.886	.872	.101	.113				
Total financial support to R&D Projects		.877		*.310*				
Total number of R&D Projects	.837		.227		-.121		.115	
International articles	.805	.822	.408	.429			-.156	
Trained personnel	.802	.824		.101				.188
Patent applications	.706	.676			.119			
Total number of Mod. 2 contracts (R&D contracts)	.241		.525		.267		.557	
Total budget of Mod. 1 contracts (Technology Support)		.148		.761				*.345*
Total number of Mod. 1 contracts (technology support)			.858				.187	
Total budget of Mod. 2 contracts (R&D contracts)		*.383*		*.307*		.153		.633
Average size of research group in R&D Projects	*.389*	.430	-.180	-.117	-.495	-.446	*-.397*	-.431
Average size of research group in PETRI Actions			.842	.903			-.219	-.133
Total financial support to PETRI Actions		*.308*		.898				
Total Number of PETRI Actions	*.359*		.731					
Average size of research group in Concerted Projects	-.104				.918	.956	-.149	
Total financial support to Concerted Projects		.261		.189		.895		
Total number of Concerted Projects	.286		.266		.798		.220	
Average age of research group				-.104			.803	.765

Extraction method: Principal Components Analysis. Rotation method: Varimax Normalisation with Kaiser.
Rotations converged after 5 iterations.
Coefficients of factor with eigenvalue lower than 0.1 have been deleted.
Bold characters: significant coefficients (|coeff.|≥0.4)
Italic characters: less significant coefficients (0.3≤|*coeff.*|<.0.4)
Normal characters: non-significant coefficients (0.1≤|coeff.|<0.3)
* using number variables in first column of each factor and using money variables in second column of each factor

The second analysis explains 76.1% of total variance with four factors and analysis one just reach 73.0% so both explanations are rather similar.

[2] The rest of information provided by these two analyses is included in table 3 in the annex.

Factor one of the second analysis explains 37.6% of the total explained variance. In the case of analysis one the factor one explains 35.3% so its interpretation in both analyses is meaningful. Using the second analysis we can describe this factor as a high quality-performance variable since two types of tools and one of contracts are represented. It combine variables that help characterise research groups with large scientific inputs and scientific-technological outputs and also participating in R&D contracts and PETRI Actions, being these last two coefficients less than 0.4. The comparison of this factor in the two analyses show that R&D contracts are non significant in terms of number but in terms of the involved budget presents a slight significance. This represents the quality of these contracts. Also, these contracts are related to technological outputs, in a similar way as it is described in the case of a Spanish university (Azagra, et al., 2003) where it is shown that patents do represent an output of long lasting and large budget R&D Contracts. Changes in coefficient variables of PETRI Actions between the two analyses are due to the higher weight of this variable in terms of number in comparison to the variable in terms of financial support.

The second factor explains 17.1% of total variance in the second analysis and 18.3% in the case of the first analysis so its explanation has dropped but again both analyses provide a similar explanation on it. This second factor represents a variable of not so high performance groups which might need some financial support from other SFTP tools in order to co-operate with firms, cooperation that afterwards takes the form of a Technology Support contract. It combines variables that may help characterise smaller size groups (in comparison to the previous factor) with a high participation in PETRI Actions and bilateral contracts of both types, specially the Technology Support ones. It also shows important scientific outputs (again lower with respect to the previous one). This is representative of the role of the PETRI Actions: they favour, to some extent, relationships and, at the same time, the transferred research results can be characterised as low scientific-technological level according to the production environment characteristics.

The third factor explains 11.8% of total variance in the second analysis and 10.7% in the first one but still we can offer an explanation on it. We describe this factor as a new variable representing low level technology development activities. This factor combines variables representing the participation in Concerted Projects with low average size of research groups. This is due to the fact that these projects arise as a firm's demand and this demand can be covered in many cases with a consultant collaboration of a researcher but usually do not need the potential of the whole research group or a hard work in the laboratory. This means that these types of activities usually imply low level technology changes.

Finally the fourth factor explains 9.6% of total variance in the second analysis and 8.7% in the first one. This last factor represents the role of R&D Contracts as an indirect way to co-operate with firms mainly used by elder researchers, whose professional career has reached the top and is not an incentive anymore for them. This result is also supported by the interviews carried out with research group leaders who declare that elder researchers traditionally have collaborated with firms and nowadays still collaborate but this is not the case of younger researchers who prefer to focus their activity in producing scientific outputs since this is the actual promotion way. The factor combines variables representative of average age with R&D contracts (both in terms of number and budget involved) with a negative role of the average size of the research group in R&D Projects.

In order to complement the factor analysis previously introduced we have carried out a cluster analysis in order to obtain more or less homogeneous groups of observations who have participated in the SFTP. The variables used in this technique are the same ones used in the factor analysis. Hence the results are homogeneous and comparable. For the cluster analysis we have used the set of variables representing the number of activities carried out

complemented with the ones representing the research group characteristics, the scientific-technology outputs produced with R&D Projects and the participation in bilateral contracts. We have decided to use the variables representing the number of activities due to the higher weight of financial support variables in Concerted Projects: this variable introduces a magnitude order much higher than the rest which in the end distorts the results of the cluster technique. The main result of the cluster analysis that we here represent is the dendrogram[3] or tree diagram which groups together the observations according to the distance that separate them using the selected variables. Therefore those clusters will group observations with a more or less homogeneous behaviour or characteristics.

The dendrogram that we have obtained is represented in figure 2 and shows five differentiated groups that we can transform into three according to the distances between the observations. Thus we can join the clusters 1 and 5 and, on the other hand, the clusters 2 and 3, being the observation of cluster 4 an exceptional or atypical one due to its higher scientific output (it is twice the average scientific output of the rest of observations).

When we connect this information to the one obtained with the factor analysis and that reflected in table 1 of research activity we can conclude that clusters 2, 3 and 4 obtained in the cluster analysis represent those groups who have actively participated in the SFTP and, in addition participate in bilateral contracts with firms of the Food Industry with a large distance to the other clusters (groups 1 and 5). These groups do correspond to those referred in Fernandez de Lucio et al. (2003) as the most productive 20% in terms of scientific and technological production. Therefore this lack of symmetry in the distribution of groups allows as to state and claim for a differentiated management for these two different types of research groups participating in the SFTP.

Finally and regarding the measure addressed to the creation of technology institutes the results are conclusive: since 1988 only two technology institutes have been created and both have been created on the basis of two existing ones. Hence, we can consider that this measure has dramatically failed: the Food Industry did not want to support the investments and expenses to maintain the technology institutes network and, as a consequence, the administration finally abandoned this initiative.

Conclusions

The analysis carried out on the three types of tools provides us with useful information to determine to what extent research groups and firms have applied to the SFTP in order to increase their research activity in this area. That way we are able to state that this policy has been partly useful to increase research activity of CSIC groups and firms of the SFBI.

First, we confirm the low acceptance of the provided SFTP's tools to promote collaboration among the agents. Spanish food industry firms neither have supported the administration attempts to create Technology Institutes in specific sub sectors nor have participated in one of the Relationship Tools (Concerted Projects) devoted to financially support their technological developments with the collaboration of research groups. With regard to the analysis carried out on the CSIC research groups we show that those with larger inputs and outputs do collaborate with firms basically through bilateral R&D Contracts. Whereas the supplied SFTP tool to promote relationships of research groups with firms, PETRI Actions, is useful for another type of research groups with good scientific outputs and some scientific results which

3 Dendrogram is included in annexe as figure 2.

further application might need the administration support to be transferred generating afterwards Technology Support type of contracts. This means that PETRI Actions although weakly (due to the few actions financed), do have fosterer the relationships between the scientific and production environments. If we pay attention to the large figures of the SFTP, we can observe the predominant role of the R&D Projects than PETRI Actions and Concerted Projects. The SFTP has been useful to finance active research groups who afterwards sign contracts with firms to some extent according to the existence of a good feeling stream with respect to the development of such collaborations and the support to increase the involved management.

Therefore, we can conclude that the SFTP, considering its weaknesses, has indirectly fostered some articulation within the high quality and performance research groups through R&D Contracts. In addition, it has also fostered some direct articulation within lower quality research groups through the PETRI Actions.

The indirect and direct articulation has been favoured to a large extent by the Interface Structures. Their contribution to the generation of that good feeling stream with respect to the generation of relationships with other System agents has provoked the indirect articulation. On the other hand their SFTP's tools proactive management has contributed to the participation of research groups in Relationship Tools such as PETRI Actions. This is shown in the analysis carried out in the CSIC: one of the analysed institutes, the IG shows an important increase in the number of PETRI Actions (with more of 40% of the total for the CSIC). This fact is a consequence of the establishment of the Technology Transfer CSIC Office in that area in 1992 to provide support to the research groups, manage the Relationship Tools and facilitate the collaboration of those groups with the other three surrounding environments.

The factor analysis carried out allows us to distinguish CSIC research groups into three categories according to their input and output variables. First, those groups that we consider as the *consolidate* ones (a small set of groups which nonetheless absorbs the largest proportion of scientific inputs and outputs). Second, those *emerging* groups that appear thanks to the policy and show acceptable scientific input and output levels, and finally those considered as "*shooting stars*" which despite the support received from the SFTP, do not show acceptable levels of scientific-technical outputs. The two first sets show remarkable levels of relationships with firms and, therefore contribute to the Spanish Food Innovation System articulation basically trough bilateral contracts with a more scientific character in the case of consolidated groups and technical character in the case of emerging groups.

On the other hand, the analysis carried out on the interface structures role (both the structure responsible for the policy management and the interface structures at universities and public research institutions) allows us to demonstrate the importance of the management in order to achieve the objectives stated in the policy so that it actively contributes to the consolidation of an articulated Innovation System. More specifically, it is shown that the lack of human resources at the structure responsible of the policy management has been crucial and the reason why it was not possible to offer a proactive management of financial tools. As a consequence, we find a loss of additionality in the policy when the goal was to induce a new behaviour into the agents, that is, a collaboration culture. On the other hand, interface structures do have shown themselves as key elements at the time of increasing the agents application to the SFTP financial tools. Those interface structures able to carry out the "catalyser" role for the relationships, have shown themselves as active participants in the rise of the number of collaboration in research activities between research groups and firms at both the level of those promoted by the SFTP and those privately promoted such as bilateral contracts.

Consequently, to set in motion *ad hoc* financial tools is a necessary condition to favour changes in behaviour and attitudes, as it is the case of the SFTP in the promotion of research in collaboration, but is not a sufficient one to ensure their successful implementation and efficient use. It is also necessary managerial structures able to ease the agents' access to the tools.

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Annexe: Factor analysis

Total Variance Explained

Analysis considering variables of number (analysis 1)				Analysis considering variables of involved budget (analysis 2)			
Component	Initial Eigenvalues			Component	Initial Eigenvalues		
	Total	% of variance	Cumulated %		Total	% of variance	Cumulated %
1	4,588	35,289	35,289	1	4,883	37,565	37,565
2	2,384	18,339	53,628	2	2,220	17,076	54,642
3	1,392	10,707	64,335	3	1,537	11,819	66,461
4	1,131	8,697	73,032	4	1,247	9,589	76,050
5	,929	7,143	80,175	5	,874	6,721	82,771
6	,641	4,933	85,108	6	,654	5,030	87,801
7	,548	4,217	89,325	7	,481	3,698	91,499
8	,471	3,625	92,950	8	,381	2,930	94,429
9	,294	2,264	95,214	9	,312	2,400	96,829
10	,255	1,960	97,175	10	,202	1,551	98,380
11	,147	1,133	98,308	11	,090	,694	99,074
12	,130	,999	99,307	12	,076	,581	99,655
13	,090	,693	100,000	13	,045	,345	100,000

Extraction method: Principal components analysis.

Figure 2. Dendrogram using Average Linkage (Between Groups)