

The Evaluation of the Spanish Food Technology Programme: coherence between policy formulation and policy implementation

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In this paper we analyse the coherence existing between the formulation of Spanish Science Policy and the instruments implemented to achieve the goals established within that policy. For that purpose, we evaluate the case of the Spanish Food Technology Programme. We find that this policy has been designed under a linear model conception. However some programme goals are fundamentally structuralist-oriented. Consequently in their formulation the instruments implemented to achieve those goals have been used following a clear neoclassical approach.

The methodology used to evaluate that Spanish public policy draws on Callon's "technoeconomic network" and is inspired by Lipsey and Carlaw's theoretical framework on the "facilitating structure". We use them to analyse to what extent this policy has been the suitable tool to generate "articulation" within the Spanish Food Innovation System, as one of the structuralist-oriented goals of the programme.

Our main conclusions relate to the need of a better coherence between policies, goals, instruments and policy makers, otherwise the expected results would not be achieved. We also conclude that in order to demonstrate expected results evaluation methodologies have to evolve toward new structuralist-driven methods in search of a better fit between policies, goals and evaluation results.

1. Introduction

Science policy formulation is a relatively new process in Spain which origins can be traced to the first democratic government in 1977 (Sanz, 1997). This short period of time has its direct translation in several obstacles due to weaknesses in the implementation of policies and their further evaluation.

Within the capitalist world we can find one unique trend in the formulation of policies built around the concepts of equilibrium and intervention to correct market failures in the allocation of resources (Metcalf and Georghiou, 1998). However, nowadays a new approach is gaining adepts among scholars in Economics and politicians. This perspective implies a departure from the neoclassical conception of economics and policy in order to show and gauge the variety of behaviours and selection processes. These will be considered as key elements in the analysis of economic results and consequently in the formulation and implementation of policies according to the so-called Structuralist-Evolutionary perspective¹.

In the specific case of the evaluation of public policies supporting R&D and innovation activities, now it is possible to consider that process as a common one and fully incorporated in the socio-economic activity of several developed nations. Consequently, we find abundant bibliography dealing with the evaluation of those policies (Gibbons and Georghiou, 1987; Roessner, 1989; Georghiou and Meyer-Krahmer, 1992; Becher and Kuhlmann, 1995). The main aim is to provide policy makers with results that can be used as a judgement basis to readdress policies toward targeted goals.

It has taken longer for Spanish society to realise the need for the evaluation of public activity in general and, more specifically, that which concerns science and technology policy. The announcement of the "Science Law"² in 1986 and the subsequent implementation of the National R&D Plans in 1988 provide the key dates of the process of institutionalisation of the support for such activities. This process encompasses evaluation activity, previously reflected in sporadic reports, which lacked a commonly accepted methodology or some regularity in order to be considered reliable. Following the implementation of the National R&D Plans there was an incipient trend towards evaluation during the 1990's which will undoubtedly offer results of interest for both public policy makers and practitioners connected with these topics (Fontela et al., 1992; Criado et al., 1993; Acosta and Modrego, 2001).

So far, most evaluations of the National R&D Plans have focused on the results relating to the resources (both financial and human) involved in their particular programmes, as well as the outputs produced with those resources such as publications, patents or trained personnel (Espinosa de los Monteros et al., 1994). However, none of them show results regarding the relationships that have been fostered using those resources, being this one of the objectives specified and pursued by the R&D Plans. Furthermore, from a structural point of view, those relationships are considered crucial for building and consolidating a real Innovation System. Little work has been done in relation to this topic. Only Acosta and Modrego (2001) address the point by offering an integrated approach to economic and structural aspects, but fall short of explaining the reasons for co-operation between Public Research Centres (PRC) and firms.

The underlying hypothesis used in this paper refers to the role of evaluation in the policy cycle. We analyse to what extent evaluation results mainly focus in inputs and outputs analyses due to the use of a linear model framework to analyse innovation processes. Hence, we wonder to what extent the National R&D Plan has been formulated under such framework and, as a consequence, the related correcting measures addressed to solve a market failure in the allocation of resources for R&D mainly consist of subsidising these activities which can be considered as a neoclassical use of the tool. Therefore it seems reasonable to think that the evaluation of those activities will use methodologies that also fit the linear innovation model and the neoclassical approach if exists any evaluation process.

This paper is part of the results of a larger project³ and specifically puts forward the need to formulate coherent policies in their approaches and objectives so the tools used to reach the objectives also keep the same coherence. It also puts forward the need to modify the evaluation methodologies in the sense of making them coherent to the way in which policies are formulated. This paper offers results on the evaluation of the Spanish Food Technology Programme (SFTP), which has been part of the National R&D Plans since 1988. After the analysis of the SFTP, we can conclude that is inspired by a supply side framework where the "science push" innovation linear model is used under a general framework of market failure. However, we observe that some objectives, considered as key in the Plan have been formulated under a Structuralist-Evolutionary perspective breaking with the general framework of the Programme which may cause some inconsistencies. They arise again when we analyse the tools used to reach those objectives. Hence, the evaluation of the tools addressed to the generation of articulation among agents of the Spanish Food Innovation System falls in inconsistencies when evaluating those objectives fostered with tools used under a neoclassical approach. Therefore it seems necessary to establish an evaluation methodology that helps us to describe the role of the management structure of the SFTP. This must be considered as the political body that adapts to changes in organisations and agents involved in the innovation process.

2. Structuralist-Evolutionary Approach to the Innovation System and its application to the Evaluation of Public Policies

The Innovation System concept is by now widely established among economists and politicians, and it is possible to sustain the application of several methodologies under the auspices of this idea. Regarding the evaluation of public policies, the underlying IS approach has provided us with several models and methodologies to bring the results of a programme evaluation closer to the institutional network, social actors and relationships as main components of the Innovation System (Freeman, 1987; Lundvall, 1992; Nelson, 1993). The Structuralist approach allows us to make explicit both technology and institutions and studies their relation to the generation of technological change. Under this approach, technological change is considered endogenous from the point of view of its response to economic incentives (Nelson and Winter, 1982; Soete and Arundel, 1993). Moreover, the application of the “structure” concept to the evaluation of a public policy supporting R&D and innovation is of interest because it allows us to find out to what extent such a policy is the right tool for fostering the articulation of the Innovation System. We consider that the Innovation System is articulated when its elements easily interact one another to produce innovations (Landabaso, et al., 1999). In this respect, we define the IS’s articulations as the embodiment of *relationship tools* and *Interface Structures*⁴ that foster, catalyse and facilitate relationships among the System’s elements aiming at generate innovations in the same way as the articulations of the human body favour displacement by facilitating movements. On the one hand, the interface structure’s goal is to “dynamise” the IS’s elements (Castro, et. al., 2001) with respect to innovation topics as well as to facilitate and catalyse their relationships through different types of activities. On the other, the relationship tools tend to favour relationships among the IS’s elements basically through financial stimulus. This scheme is consistent with the characteristics of IS in peripheral regions: they tend to be fragmented and few relationships among the elements are found because of the lack of articulation and “dynamisation” of the elements toward innovation. Hence, governments in these regions use to implement innovation policies supported by relationship tools and interface structures as it is the case here analysed.

In addition to the importance of the interface structures we consider highly relevant their managerial staff as the people who is dealing both with the relationship tool itself and the IS’s elements. This idea departs from Lipsey and Carlaw’s scheme (1998). They emphasise the concept of the “facilitating structure” as the embodiment of existing technological and organisational knowledge. Such a structure is influenced and altered by technological factors as well as by the structure managing public policies. This approach is consistent with the idea of evaluating an R&D Programme fostered and managed by the Administration. Under this scheme, a technology policy is defined as the search for certain objectives, which have been expressed in a specific programme, as well as the specification of the means to achieve those objectives. The implementation of such policy will influence the facilitating structure, which will also receive the influence of the factors supplied to the system in the form of human and physical capital as well as the actual technology. This interaction process will generate measurable economic results, which are finally evaluated.

These relationships are precisely the key to our analysis and methodology and those used by different scholars and practitioners who study in depth the structural aspects and, more specifically, the articulation aspects when analysing and evaluating the implementation of a particular programme supporting R&D activities. Thus, *network analysis*, on its economics side, offers a measure of the types of relationships found among the actors or institutions of the System. Within this framework, there are several methodologies with a more or less macroeconomic results. The *network analysis* used for the evaluation of specific programmes provides us with a measure of the relationships created between the research units (research institutions, R&D units of firms, researchers, etc.) taking part in the programme. Such a methodology is applied by Lahlou in the evaluation of the European Commission’s Science and Stimulation Programmes (Lahlou, 1997). This is a quantitative methodology in which the units of analysis are observed *before* and *after* the collaboration in the programme evaluated. The network characterisation is carried out through an indicator of the relationship between pairs of the observed units, which give shape to the network studied. Such an indicator is calculated according to the measure of these core variables in the quantification of the relationships. The possibilities of applying this methodology to the Spanish case seem to be rather distant: first, the Spanish Innovation System (SIS) is quite young: it would seem inappropriate to apply to it and to measure the network concept, which requires durable relationships that shape and characterise the Innovation System in developed countries,

where there is a long tradition of R&D and innovation activities; second, the links among the various elements of the SIS are very tenuous (Fernández de Lucio, et al., 2000), which obstructs the application of the network concept at this stage; finally, there is very little participation by Spanish food firms in R&D activities (COTEC, 1998; 2001). This reduces any possibility of analysing and evaluating the public programmes supporting such activities with this methodology, since the participation of firms is considered to be a key element.

A less quantitative methodology, but also used to analyse relationships and structural effects, is Callon's techno-economic network analysis (Callon, et al., 1992; 1997a; 1997b). Under this methodology it is possible to go deeper into the participation of the different actors and institutions of the Innovation System, which influence and are influenced by each other's actions. This methodology pursues the observation *within* and *between* units, and provides us with a characterisation of the interactions among units taking part and co-operating in R&D and innovation activities. Its application provides us with results at a mesoeconomic level, which are useful for structurally characterising economic sectors and Sectoral Systems of Innovation. However, its application to the case here analysed, although promising, is still difficult because we cannot gather relevant information from the IS's elements due to the characteristics of peripheral IS: relationships tend to be scarce and discontinuous.

3. Methodology and Data

As none of the current methods to analyse and evaluate relationships and IS articulation seem suitable for the case of the SFTP, we have used a different methodology based on the actor's participation in R&D Projects, PETRI Actions and Concerted Projects⁵. To do this, we monitored the actor's participation in these three types of tools and additionally their further participation in bilateral contracts between research groups and firms. The aim of this methodology is to monitor and trace the trajectory of these actors in a way that makes it possible to characterise and analyse whether they configure a network within the Spanish Food Innovation System, or just interact sporadically, in which case it is impossible to speak about the articulation of the System.

Finally, the SFTP management has been analysed using a structured qualitative interview addressed to the Programme managers in an attempt to find out the role of the main interface structure: whether such structure has been used, among other things, to facilitate relationships among participants in the System.

The units of analysis are the heads of Research Group (HRG), representative of the R&D groups of universities and other Public Research Centres (PRCs), and the firms. The connection between these two units of analysis is their participation in the SFTP through PETRI Actions and/or Concerted Projects.

The time frame used to perform the analysis runs from 1988 to 1995, which coincides with the First and Second National R&D Plans. Additionally, this period has been extended to 1998 to analyse the information on the Polytechnic University of Valencia, as the representative case of the participation of a university in the SFTP.

The information on R&D Projects was obtained from the final reports submitted to the General Secretariat of the National R&D Plan by the HRGs. From these reports we obtain quantitative data on the diffusion of research results (articles published in national and international reviews, monographs, congresses), personnel training (measured by the number of doctoral thesis submitted), some economic results (measured by the personnel incorporated into firms or number of patent applications and patents granted)⁶. Furthermore, these reports provide us with some qualitative information on the research results obtained: whether they are mainly theoretical, theoretical-practical, practical or ready for application. It has been possible to obtain information on 343 cases, or 78% of a total of 441 projects financed during the period analysed which show the heterogeneity of the analysed research community (Fernández de Lucio, et al., 1999). Likewise, we gathered information on 56 *PETRI Actions*, as well as *Concerted Projects* and bilateral contracts. In this case, the information refers to the contracts between firms and the research groups of the Polytechnic University of

Valencia (UPV) as a representative PRI in Food Technology research.

4. Results of the Evaluation of the Spanish Food Technology Programme

4.1. Inputs and Outputs of the Programme

We show in table 1 the information on the main outputs produced by the research groups with their participation in the R&D Projects of the SFTP. The initial analysis of the frequencies of these variables reveals that they do not follow normal distributions⁷. Hence, the mean and modal values of the different variables seem more reliable and representative as statistics.

Table 1. Outputs of R&D Projects between 1988 and 1995*.

	Total Number	Mean Value	Modal Value	Frequency of Modal Value
Personnel Trained	1,270	3.1	2	20.1%
Non PhD grant holders	236	0.6	0	71.0%
PhD grant holders	76	0.2	0	86.5%
PhD Theses Submitted	641	1.6	1	29.0%
National Articles	461	1.1	0	63.9%
International Articles**	2,278	5.6	0	20.9%
Disclosure National Art.	326	0.8	0	72.7%
Disclosure International Art.	22	0.1	0	96.8%
Review National Art.	135	0.3	0	82.3%
Review International Art.	90	0.2	0	84.8%
National Monographs	264	0.6	0	74.0%
International Monographs	360	0.9	0	65.8%
National Conferences	661	1.6	0	53.3%
International Conferences	619	1.5	0	50.9%
Patent Applications**	66	0.2	0	87.7%
Patents Granted	13	0.0	0	97.8%
Spanish Pat. Applications	60	0.2	0	87.5%
Internat. Pat. Applications	17	0.0	0	96.8%

Source: Own elaboration. Data extracted from the final reports on R&D Projects (CICYT).

*These data correspond to 407 final reports on R&D Projects.

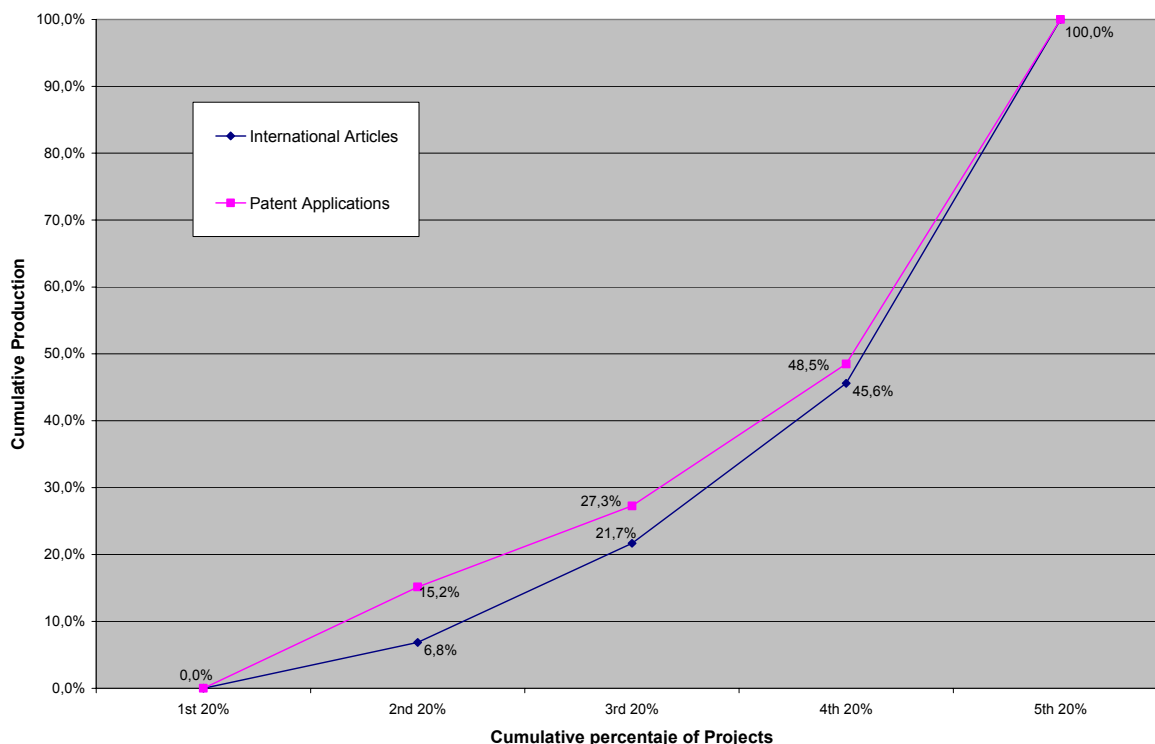
** Final reports do not specify whether these articles are included in the ISI nor the application nationality of patents. However, our revision of the information reveals that most of them are publications included in the ISI (around 92%) and most of the international patent applications are submitted to the European Patent Office (around 94%).

An initial observation of the Modal value shows zero as the most frequent for almost all the variables, including those with a mean value higher than zero. The frequency distribution of the modal value is high not only in variables with economic significance, as “patents”, but also for those variables measuring scientific outputs such as “conference assistance”, or “national articles”. The only variables with lower frequencies are “international articles”, “theses submitted” and “personnel trained”, these two being the only ones with non-zero values.

These results show the high dispersion in the outputs of R&D Projects; hence the mean value can therefore be misleading. Thus, the diffusion of research results can be considered of importance since, on average, each

project produces less than 6 international and 1 national articles. However, as has been stressed before, the most frequent value is zero. To better emphasise the heterogeneity of the research groups, the next graph depicts percentages of international publications and patents in relation to percentages of projects: 20% of the most productive projects generate around 55% of international publications. This variable fits a distribution that resembles Lotka's Law⁸ on the scientific productivity. This result almost holds good for patents, the same projects being those with the highest rate of patent applications. This heterogeneity can be found in all outputs: the most productive 20% of projects generates, in average, 40% of outputs and the least productive 20% generates hardly any output (just 3.5% on average).

Distribution of International Articles and Patent Applications according to Groups of Projects



Productivity is closely related to research group size (with a correlation coefficient of 0.98). Likewise, we have found that it is also related to the type of institution: the Spanish Council of Scientific Research (CSIC) is, in general, more productive than the universities because CSIC has a long research tradition in this area. Hence, there are much more productive groups belonging to the CSIC than to universities among the most productive ones (55% of projects included in the two most productive groups of projects) whereas the less productive groups are mainly from universities (62.5% of the projects included in the two less productive groups of projects). However, for each group of productivity, the results of CSIC or university groups are comparable. This has to do with the evolution of the number of researchers (in terms of full time equivalent, FTE) during the two National R&D Plans: after the first three years (1988-90)⁹ the number of researchers participating in the SFTP rose to 510 FTE (43% of them from universities); during the period 1994-96 this figure rose to 639 FTE (and that of the universities accounted for 63%). If we analyse the annual cumulative rate of publications included in FSTA¹⁰ during 1990-1996 we can see how the Spanish rate was 17.7% which compared to the average rate of publications recorded in FSTA (7.2%) is significantly higher, but it is also higher with respect to the European leading countries in food technology research: France (7.4%), Germany (5.9%) and United Kingdom (4.5%). These results are representative of the growth in the number of the Spanish publications in this area but are also a proxy variable of the quality of these publications.

Other significant results are those referred to personnel training: each project generates 1.6 PhD theses and trains 3 people (these variables are the only ones with a modal value different to zero). However, the transfer of these personnel to the industry has been very low: only 1/3 of the non-PhD grant holders and 10% of PhD grant holders have been recruited by companies. Clearly, it is not only possible to blame the SFTP for this

low transfer of personnel, rather to the industrial framework in which it develops. These indicators reflect, on the one hand, the low interrelation among the members of the scientific community and the production system and, on the other, the low tendency of firms in the Food and Beverages Industry to hire research personnel.

In this respect, following what seems to be a general trend in the European Food and Beverages Industry, the Spanish sector is clearly divided into two groups of firms: a large percentage of micro and small firms with less than 10 employees and a very small percentage of large firms (Galizzi, y Venturini, 1996). These two groups undertake a weak effort in R&D activities to innovate due to different reasons: the small ones because their innovation activities can be developed with the existing pool of knowledge and the large ones because belong to multinational groups which have their R&D laboratories located at their country of origin. This sector, though ranking in the fourth position in Europe as regards the added value after Germany, the UK and France, has one of the lowest GERD rates (0.13% in 2000) (INE, 2002; Trabada, 2000).

From the analysis of the types of results obtained by R&D Projects, HRG mostly think that they are mainly of a theoretical-practical character (81% of projects, Table 2). Only 3% consider results to be of a theoretical character. However, a half considers that, although the results are of a theoretical character, they are ready to be applied. This is supported by the fact that two thirds have submitted a patent although none of them has been granted. Finally, 31% of the cases are ready to be applied.

Table 2. Applicability degree of the R&D Projects results.

<i>Type of Results</i>	<i>N° of Projects</i>	<i>Ready for Application</i>	<i>Patents Applications</i>	<i>Granted Patents</i>
Theoretical	12	6	8	--
Theoretical-Practical	329	99	47	10
Practical	23	20	9	2
Ready for Application	2	1	2	1
Not Determined	41	--	--	--
TOTAL	407	126	66	13

Source: CICYT and own elaboration from the information of 407 final reports of R&D Projects.

These results show a discrepancy between the researchers' beliefs about the applicability of their results and the actual transfer of them measured through patents granted and participation in PETRI Actions and/or Concerted Projects: there are 31 PETRI Actions and 21 Concerted Projects that have been carried out by HRG who also participated in R&D Projects but the results of these projects were mainly considered of theoretical-practical character (around 75%). Even if the researchers' optimism is high with respect to the applicability, this discrepancy makes evident that the relationships between the researchers and the firms that could apply the results are weak.

4.2. Evaluation of Articulation

The starting point for the analysis of the articulation is the participation of research groups and firms in PETRI Actions. Firstly, we have considered the Actions' records to check if there is any previous background of research carried out by the group and, secondly, we have checked whether this research has had any continuity with the collaboration of the firm in further research through Concerted Projects. In the case of the Polytechnic University of Valencia we have monitored this continuity adding the information on bilateral contracts

Referred to the PETRI Actions' records, the number of financed PETRI Actions in the period is 56. This

figure, represents just 12.7% of the total of 441 R&D Projects. Only 31 (57%) of those Actions were carried out by HRG taking part in other R&D Projects of the SFTP, 9 were carried out by HRG taking part in other programmes of the National R&D Plan, and 16 (almost 25%) by HRG who did not take part in other research activities financed by the National R&D Plan. Since the number of HRG in the SFTP was 264, the percentage of HRG taking part in PETRI Actions was a poor 11.7%.

The degree of satisfaction declared by firms and PRIs is high. In the case of the PRIs, 82% of research groups have considered the Action positive and only 8% have considered it negative. Afterwards, it will be shown whether this initial high degree of satisfaction has its reflection in a subsequent continuity of the relationship between the PRI and the firm. With respect to the 25 firms that submitted their report, only 20 indicated the degree of satisfaction: 85% of the answers indicated that the satisfaction was high, 10% of answers were in the middle of the scale and only in one case, the degree of satisfaction was low. This low interest of firms is a consequence of the low interaction with the research group, as shown in Acosta and Modrego (2001).

With respect to the continuity of the Actions, 71.8% of the PRIs and 80% of the firms declare the intention of maintaining the relationship established, and the most usual form in which this continuity is envisaged is a research contract (48.7% of cases for the PRIs and 48% for the firms) followed by a Concerted Project (12.8% of cases for the PRIs and 16% for the firms). Although initial optimism is shown regarding the continuity of the relationship, in a high percentage of cases (46% for the PRIs and 48% for the firms) it is indicated that the transfer of results will not be possible in the short run.

Furthermore, after the PETRI Action, we have not detected, any research group having or maintaining the relationship with the firm through any Concerted Project. Hence, the continuity of the relationships through alternative relationship tools of the National R&D Plan is very rare. We have detected only 12 HRG participating in both R&D projects and Concerted Projects from a total number of 264 HRG in R&D Projects and 87 HRG in Concerted Projects. This means that only 4.5% of the HRG of R&D Projects participate in Concerted Projects.

There is yet another fact that corroborates this lack of continuity of the relationships between research groups and firms: the SFTP failure creating the "Research and Technology Organisations (RTO)" as one of the Programme's key tools to foster relationships between SMEs and research groups. The financial support devoted to this action involved the largest amount of the budget (35%)¹¹. However, the industry did not consider this action of interest and during the first National R&D Plan only one RTO in the sector of canned fish was created. Due to this poor result, the budget for the action was cut out in the second National R&D Plan.

Focusing on this lack of continuity, the types of results have been analysed in relation to the following characteristics: technological level, protection awarded and economic value. The results are mostly the transfer of non-original scientific knowledge of interest to the firm, although they are not protected in any specific form. In 43% of cases it is considered unnecessary to protect the results for several reasons: the firm is not interested in protecting them, or a confidentiality agreement between the PRI and the firm exists, or the firm has considered it necessary to carry out more tests. Only in 18% of cases, has a patent been applied for. The remaining cases did not answer the question. The amount involved in the transfer of results did not exceed US\$ 10,000 in any case. From this analysis it is possible to conclude that the technological level of the results obtained with the PETRI Action is medium-low.

4.3. The Articulation at the Polytechnic University of Valencia

The case of the UPV will be used to complement our analysis of the articulation. We consider it a representative institution in food technology research for several reasons: the participation of this university accounts for 6% of the total participation, after CSIC (40% of the total) Complutense University of Madrid (15.5%) University of Zaragoza (7%), University of Barcelona (6.4%). The sample of research groups encompasses those consolidated with a long tradition in Spain in this field as well as those emerging after the

implementation of the SFTP. There are also some differences in the size of groups. Besides, we have had access to two important sources of information: on the one hand, the Interface Structure, the Technology Transfer Centre (TTC), created in 1989 to support researchers¹² and on the other, the bilateral contracts signed by this university with firms. This will be used to find any trace of network generation supported by them since, as it was previously said, researchers and firms tend to maintain an initial relationship through this type of agreement. We have gathered information of both the activities financed by the SFTP and the bilateral contracts carried out by the Food Technology Department of this university in the course of 11 years¹³. This department has carried out 21 actions of the SFTP, including 15 R&D Projects, 4 PETRI Actions and 2 Concerted Projects. In addition, the university has signed 29 bilateral contracts fully financed by the firms, representing the relationships fostered.

There is not a high degree of professional interaction among the researchers of this department. There are two groups around two professors to whom two other lecturers have been associated. The other lecturers in the department do not come into contact either with these two groups or with each other. Concerning the articulation with the socio-economic environment, it is observed that those lecturers, who do not come into contact with any of the others, generate sporadic and non-significant relationships. The analysis will focus on the two consolidated groups around the two above-mentioned professors¹⁴ who represent and absorb 90% of activities carried out under the SFTP and 75% of contracts. In one of these cases, a strong relationship can be observed with the Food Industry Research Association (AINIA), which is a nationwide Research and Technology Organisation (RTO). The other group shows a strong interrelationship with a disperse socio-economic environment during the first years of the time frame. This changed in 1995 when the Technology Transfer Centre (TTC) of the UPV established a specific line of support and help for lecturers with their relationships with firms. This support has meant the development of 2 PETRI Actions and 1 contract related to a specific topic between this group and one firm since 1996.

These results reflect, on the one hand, that it is necessary to obtain information on the bilateral contracts in addition to that on the activity financed by the SFTP, since there is no trace or networking analysing the SFTP relationships tools solely. On the other, the analysis have to focus on the research groups with a wide R&D activity (research groups generate knowledge, not technologies). The university research groups have the inherent tendency to establish relationships with the socio-economic environment but tend to react sporadically to the firms' calls. Only if they receive special managerial support, will undertake them systematically and turn them into a system to boost their research activity. It is necessary to keep in mind that lecturers have a strong pressure of competing activities used to evaluate them: teaching and research.

4.4. The Role of the Managerial Structure

This paper encompasses the evaluation of the first two National R&D Plans. This is the first time that a Spanish administration has devoted significant amounts of money to the support of research activity in a systematic fashion¹⁵. Hence, the responsible management body (the General Secretariat of the National R&D Plan) tried to distribute the funds to those research groups with higher research capacity, according to an impartial and independent evaluation of the projects submitted. The evaluation consisted of two phases: first, applying peer evaluation methods to the scientific quality of the proposals submitted to the National Evaluation and Planning Agency, and second at the Experts Committee, evaluating the suitability of proposals regarding Spanish food context.

Technical management of the Plans was given to the Secretariat of the National R&D Plan, which had only a small staff, temporarily transferred from the PRIs¹⁶. Therefore, the SFTP was managed by just one prestigious researcher on a part time basis¹⁷ in this area with a small administrative staff. Under these circumstances, regardless of the manager's capacity, the management of the Programme was passive, just trying to distribute the money assigned for this area fairly among the different proposals submitted by the research groups being their scientific interest the most important criteria.

Different people, also with very few administrative staff, managed the PETRI Actions for all the programmes of the National R&D Plan in another department of the General Secretariat. Hence, these

Actions, mainly arising from research groups, were managed in a passive way and a weak co-ordination with the rest of the programmes. Finally, the Centre for Technological and Industrial Development (CDTI), belonging to a different Ministry, managed the Concerted Projects without any co-ordination with the departments of the General Secretariat of the National R&D Plan. These projects emerged as a response to the demand of industry for scientific support from research groups. Summarising, the lack of co-ordination in the management of the three types of relationship tools has decreased the possibility of facilitating relationships among the System's agents¹⁸.

Summarising, the management carried out so far, has not applied different managerial methods to the heterogeneous scientific community, nor has sufficiently influenced in the relationship of research groups with other System's agents, boosting their scientific capacity to co-ordinately look for solutions to technological problems nor has succeeded, as it was expected, in the creation of RTOs envisaged in the SFTP.

The experience acquired through these two National R&D Plans has to be helpful in changing the guidelines for the third National R&D Plan as well as its management. Among the relationship tools of the new Plan were included those of articulation grouped into the PACTI (Programme for the articulation of the Science-Technology-Industry System). With respect to the management, the report of the Third National R&D Plan stated that "...the management should be more active and should become the "engine" for the creation and co-ordination of consortiums, evaluation and monitoring of actions... Nowadays the necessary managerial staff is a critical issue. It is a primary goal to hire personnel because the General Secretariat staff counts on the same human resources since 1989" (CICYT, 1996). Unfortunately these changes in the management could not be achieved and its weakness has increased.

8. Conclusions

The indicators of scientific production and training show that the SFTP has been very helpful for the quantitative and qualitative consolidation of a significant scientific community in the food technology area. The growth in the number of researchers during the period of analysis has been small (25% during the eight years). According to the number of publications recorded in FSTA, the Spanish publications ratio has increased from 1.8% in 1990 to 3.6% in 1996, having exceeded France in absolute terms. These indicators also characterise this community as heterogeneous with the presence of consolidated groups which coexist with other emergent teams. The consolidated ones are bigger and with a large scientific trajectory and mainly belong to CSIC institutes. However, some universities count on one or two of these consolidated groups (as it is the case of the UPV). On the other hand, the emerging groups arise basically within universities, in such a way that during the last years of the analysed period the number of researchers at universities is larger than in the CSIC.

If we consider this heterogeneity a usual phenomenon in most of the scientific communities according to Lotka's Law then the use of mean values, as it is usual, for the outputs in the evaluation of these communities, can lead into error. Thus, it seems necessary to use other statistical values according to each output distribution.

The indicators used to measure knowledge transfer effects of the Programme have smaller values than those of the scientific or training effects. Most of the tools analysed were designed and implemented to increase the SFTP's research results transfer effects. The analysis of results demonstrates that they have not been as fruitful as it was expected, despite the initial satisfaction manifested by the researchers who have participated. The Programme shows an important gap between the applicability degree of the results according to the researchers and their actual application as well as between trained personnel and that transferred to firms. This cannot be attributed just to an excess in researchers' optimism, but also to the characteristics of the Spanish Food and Beverage sector.

Our methodology for the evaluation of the Programme using the Innovation System approach seems to be

suitable, not only because it proves that it is necessary to transfer knowledge to the other agents in the System in order to generate wealth in a region, but also because it highlights that the performance and efficiency of the System depends on the agents' potential and on their interactions. The measure of these interactions does not seem to be adequate if we just monitor the SFTP relationship tools due to the weak articulation of the Food Innovations System. Indeed, the percentage of researchers taking part in PETRI Actions and Concerted Projects is very small (11.7% and 4.5% respectively) and we have not found any research group that has established a relationship with a firm through the linking of the three different scientific-technological activities of the SFTP. Hence, it is also necessary to use information on bilateral contracts to make this analysis richer. Our analysis at the Polytechnic University of Valencia, incorporating the information of contracts, have shown some interactions that the analysis of the Programme's relationships tools solely did not show. However, only 20% of research groups sporadically collaborate with firms. The network creation and its further consolidation need to count on technical support and specialised management, as it has been shown through the role played by the interface structure at the UPV (fostering and supporting relationships of research groups with firms), because as it was said before, researchers' interests are mainly scientific and firms in the food and beverages sector do not pay enough attention to technological aspects. Within our approach we assimilate the interface structure concept to Lipsey and Carlaw's "facilitating structure".

The design of the SFTP followed a linear innovation model and the results obtained with our analysis show that the SFIS performance is the result of an interactive innovation model. Therefore, our methodology is useful to detect how the System's agents perform and hence, it is possible to better design research support tools of Programmes.

The SFTP integrated articulation as part of its philosophy in its conception, but the management could not assume this approach due to a lack of human resources. The change in the management must be solved in order to focus it on homogeneous groups of researchers and develop a more active management. This new way of management, as it was recognised in the Third National R&D Plan report, will need to effectively coordinate among Programmes managers, also with the PRI interface structure network and other national or regional R&D programmes involving the participation of the SFIS.

In addition, as we show through the experience at the UPV's interface structure, there have to be a real management support from the PRIs' Interface Structures, in order to sensitise researchers to transfer their results to the society supporting them in the activities addressed to reach that end. SMEs also need to count on the support of RTOs and other liaison structures closer to the firms to ease their access to innovations.

9. References

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- ¹ We have preferred to follow Lipsey and Carlaw's framework which combines the Structuralist and the Evolutionary streams since both of the two deal with economic growth issues. The first one from a macroeconomic point of view and the second one from a microeconomic one but both are necessary to analyse the whole picture.
- ² Law 13/1986 of April 14th on the Fostering and General Co-ordination of Scientific and Technological Research, commonly known as "Science Law".
- ³ This paper is based on the results of the Project SEC96-0673 financed by Interministerial Commission of Science and Technology (CICYT). The results of the evaluation of the Spanish Food Technology Programme are shown in this project.
- ⁴ We have found similar features to one specific Interface Structure to what is referred in the literature as Industry Liaison Offices (ILO), as an interface structure next to universities and/or public research institutions. Further characterisation of the Spanish Interface Structures can be found in Fernández de Lucio and Conesa (1996) and more recently in Fernández de Lucio et. al. (2000).
- ⁵ R&D Projects, PETRI Actions and Concerted Projects are the three tools financed by the SFTP to support R&D Activities. PETRI Actions and Concerted Projects are the two of them supporting R&D activities between research groups from Public Research Institutions and firms. R&D Projects are addressed just to research groups of public research institutions.
- ⁶ All the results from this part of the projects have already been presented at the "DRUID 2002 Winter Conference", held in Aalborg (Denmark) in January 2002. Proceedings available at the website <http://www.druid.dk/conferences/winter2002/papergal.htm>
- ⁷ The analysis of distributions applied to these variables reveals that some of them follow a binomial distribution, some others a Xi squared distribution and others have no clear distribution adjustment.
- ⁸ We have estimated the parameters of the functional form $f(x) = \frac{C}{x^b}$, being the values of $C = 0.3574$ and $b = 1.4569$.
- ⁹ We consider a period of time of three years because this is the average length of the projects, actually the length of more than 90% of them is three years.
- ¹⁰ FSTA is the specific data base of scientific publications in the Food Technology field and includes the most recognised international journals of the area.
- ¹¹ The SFTP states that the transfer of technology will be the articulation mechanism. The tool designed to reach that end was the Research and Technology Organisation (RTO). This action absorbed US\$ 11 million, almost one third of the total budget.
- ¹² The Technology Transfer Centre (TTC) at the Polytechnic University of Valencia is an interface structure aimed at fostering relationships between this university's scientific community and others agents of the SIS.
- ¹³ The period of time considered for the analysis of this university is longer due to the long run effects of most of these activities.
- ¹⁴ In order to measure the constant and convergent articulation with the socio-economic environment, the existence of two or more contracts with a firm along the time frame has been considered.
- ¹⁵ Up to this point, university research groups have had very scarce public funds to carry out any research activity.
- ¹⁶ This personnel transfer to the administration was already established in the Law of Science (art. 7.2.c).
- ¹⁷ There have been three different managers of the SFTP during the two National R&D Plans.
- ¹⁸ According to the Third National R&D Plan report there is the following mention on the managerial structure of the first and second National R&D Plans: "the lack of resources for the management of the Programmes has obstructed the co-ordination of the different actions... this lack of human resources contrasts with the practices of other countries". CICYT (1996) *III Plan Nacional de I+D. 1996-1999*. Madrid, pp. 59-60.