Cooperation for innovation as knowledge exchanges: a view from innovation surveys

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Abstract – **The main assumption of the paper is that cooperation for innovation is a knowledge exchange process, driven by people. It stresses the importance of knowing who knows what -and does what- in the firms. The cooperative behavior of firms in innovative activities is analyzed from several data sources and using such data in different ways. The results obtained show unmistakably that "scientifically and technically trained employees" are among the most relevant variables to understanding the cooperation for innovation within the Uruguayan industry.**

Keywords - Innovation surveys, cooperation, absorptive capacities, innovation policy, Uruguayan industry

I. Introduction

Appreciative theory with a neo-schumpeterian turn [1], [2] has forcefully stressed the importance of cooperation to improve the capacities to innovate at firm level. Moreover, research on the usefulness of innovations for specific social actors insists on cooperation as a main explanatory factor in the observed results [3], [4]. Cooperation for innovation involves various types of "external" actors: other firms, universities, scientific and technical service providers, clients. Innovation surveys have seldom included users (as different from clients) as partners for cooperation. However, early in innovation research users were recognized as a powerful source of innovation [5]; the expression "user-driven innovation" has become fashionable recently [6].

The identification of the factors that can foster or hamper the propensity of business firms to cooperate for innovation are highly context dependent, as any factor embedded in the cultural milieu in which it operates. Some assumptions can be made to give an a priori framework for empirical work, both to propose indicators and to interpret results:

i) Cooperation with external actors with the aim to better innovate is related to knowledge exchanges.
ii) Knowledge exchanges are embedded in people, and therefore what people know (in the firm) is important to assess the scope of such exchanges.
iii) Knowledge exchanges involve a good deal of tacit knowledge.

This framework leads to understand cooperation for innovation as a substantively "people driven activity", even when it is performed through formally institutionalized agreements. This leads to look with particular care at the different types of knowledgeable people within the firm, at what they know, at the efforts done to update and upgrade what they know and, last but not least, at the opportunities they are given to exploit their creativity while developing their organized work. The latter has been included in some innovation-related empirical work, [7], [8] but has not yet entered into the main recommendations for comparative research on innovation.

Innovation surveys should provide guidance for policies that aim at fostering cooperation for innovation between firms and other actors [9]. So, making the best of available innovation data and presenting better alternatives for collecting such data seems to be a valuable exercise. This is what we attempt to do in this paper for the Uruguayan case.

In section II we present some characteristics of innovation in Uruguayan industrial firms: our findings confirm the role played in cooperation by knowledgeable people, even in a weak innovative environment [10]. In Section III we organize the empirical data avaliable differently, which allow us to criticize the accuracy of the innovation survey results taken at face value. Nevertheless, the importance of knowledgeable people for cooperation is reassured. In section IV we briefly discuss some recent empirical studies that include knowledgeable people as a key issue. In Section V we present some conclusions and suggestions for future work.

II. The Uruguayan Innovation Survey 2001-2003

The results of the Uruguayan Industrial Innovation survey (IAS) covering the period 2001-2003, was released in 2006 [11].

The following two tables show the distribution of TPP innovative firms (Technologically new or modified Products and Processes) by size and in relation to characteristics of particular interest. Given our concern about the knowledgeable people in the firm, each of these tables includes columns indicating whether or not such firms have or not university graduates in their staff and whether or not they have scientifically or technically higher education trainees (STT) in their staff. STT porfessionals are those with training in physics, chemistry, mathematics, statistics, medicine, biology and biochemistry, engineering, architecture or agricultural sciences.

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TABLE I

INNOVATIVE TPP FIRMS BY SIZE

(number of employees)

Size	% of total firms	Innovative TPP firms have professionals (%)		Innovative TPP firms have STT professionals (%)	
		Yes	No	Yes	No
5 to 9	24.1	25.7	74.3	3.7	96.3
10 to 49	54.7	43.9	56.1	30.6	69.4
50 to 99	9.6	83.9	16.1	78.2	21.8
100 to 249	7.3	89.4	10.6	86.4	13.6
250 to 499	3.0	92.6	7.4	80.8	19.2
500 or more	1.3	100.0	0.0	100.0	0.0
Total	100.0	48.8	51.2	35.0	65.0

Source: Own elaboration based on IAS 2003

As we could expect, the proportion of firms that have professionals and STT professionals varies with the size of the firm. It is particularly dramatic the drop from having professionals to having STT professionals for the small and very small firms.

TABLE II

INNOVATIVE TPP FIRMS BY SEVERAL CARACTERISTICS OF INTEREST

	% in total innovative TPP firms		% of innovative TPP firms that have professionals		% of innovative TPP firms that have STT professionals	
	Yes	No	Yes	No	Yes	No
Foreign capital	6.8	93.2	93.4	6.6	80.6	19.4
Spend in R&D	35.6	64.4	62.7	37.3	45.0	55.0
Perform internal R&D	39.3	60.7	60.6	39.4	46.8	53.2
Receive public financial support for innovation	0.6	99.4	100.0	0.0	100.0	0.0
Cooperate for innovation	**82.4**	**17.6**	**49.9**	**51.1**	**37.9**	**62.1**
Cooperate with S&T institutions	**55.1**	**44.9**	**64.5**	**35.5**	**48.7**	**51.3**
Cooperate with other firms (clients, suppliers, other firms outside their group)	**58.2**	**41.8**	**42.9**	**57.1**	**35.4**	**64.6**
Cooperate with firms within their group	**19.7**	**80.3**	**38.2**	**61.8**	**34.1**	**65.9**
Cooperate with S&T governmental programs	**6.7**	**93.3**	**71.7**	**28.3**	**48.3**	**51.7**
Cooperate for R&D*	**11.5**	**88.5**	**74.0**	**26.0**	**71.2**	**28.8**
Cooperate for R&D with S&T institutions*	**9.1**	**90.9**	**70.7**	**29.3**	**68.3**	**31.7**
Cooperate for R&D with other firms (clients, suppliers, other firms outside their group)*	**3.4**	**96.6**	**60.0**	**40.0**	**60.0**	**40.0**
Cooperate for R&D with firms within their group*	**3.4**	**96.6**	**58.1**	**41.9**	**54.8**	**45.2**
Cooperate for R&D with S&T governmental programs*	**1.2**	**98.8**	**100.0**	**0.0**	**100.0**	**0.0**
Cooperate for other innovation activities*	**65.0**	**35.0**	**52.7**	**47.3**	**41.8**	**58.2**
Cooperate for training*	**39.7**	**60.3**	**61.5**	**38.5**	**46.0**	**54.0**
Use external sources for scientific information	41.3	58.7	60.9	39.1	45.6	54.4
Obstacle for innovate with high rating: scarcity of qualified personnel	19.0	89.0	38.0	62.0	12.8	87.2
Obstacle for innovate with high rating: risk of innovation	13.0	87.0	50.8	49.2	32.2	67.8
Obstacle for innovate with high rating: insufficient information about markets and technology	15.5	84.5	47.5	52.5	16.4	83.6
Obstacle for innovate with high rating: insufficient access to financing	33.3	66.7	42.7	57.3	27.4	72.6
With professionals in R&D	18.5	81.5	93.4	6.6	100.0	0.0
Ask and/or obtain patents (Uruguay)	6.0	97.0	89.1	10.9	53.7	46.3
Ask and/or obtain patents (MERCOSUR, rest of the world)	1.0	99.0	100	0	88.9	11.1
Novelty of innovation of TPP firm: firm	57.0	----	40.1	59.9	30.8	69.2
Novelty of innovation of TPP firm: national, regional or international market	43.0	----	60.8	39.2	40.9	59.1
Novelty of innovation in products: firm	44.5	----	47.3	52.7	35.6	64.4
Novelty of innovation in products: national, regional or international market	30.5	----	57.2	42.8	32.7	67.3
Novelty of innovation in processes: firm	57.9	----	40.3	59.7	34.4	65.6
Novelty of innovation in processes: national, regional or international market	27.3	----	64.0	36.0	48.2	51.8

Source: Own elaboration based on IAS 2003

Table II shows that indeed cooperation for innovation can be seen as a knowledgeable people embedded process. "Cooperate for R&D" in its different modalities seems to imply the need of having not only professionals but STT professionals as well: between 60% and 70% of the innovative TPP firms declaring this type of cooperation have both types of professionals. It is also interesting to observe that passing from novelty at firm level to novelty at national, regional or international implies a jump in the proportion of firms that have professionals and STT professionals.

In Table III some activities related to performing R&D and cooperating for innovation and for R&D were selected "negatively", that is, the focus is in not performing the activity. The results confirm that not performing an activity distinguishes between those firms having or not having professionals: more than 60% of the firms that do not perform each of the selected activities do not have professionals.

TABLE III
NOT PERFORMING ACTIVITIES OR NOT PROFESSIONALS

	Innovative TPP firms have STT professionals	
	Yes	**No**
Do not spend on R&D	29.7	70.3
Do not perform internal R&D	27.5	72.5
Do not receive public financial support for innovation	34.7	65.3
Do not cooperate for R&D with S&T institutions	35.4	64.6
Do not cooperate for R&D with other firms (clients. suppliers. other firms outside their group)	34.1	65.9

Source: Own elaboration based on IAS 2003

III. LOOKING CRITICALLY INTO DATA

Uruguayan industry's innovative behavior is, in general terms, weak. We mean by that that the proportion of innovative firms is low, around 30% of all firms, that endogenous innovation efforts account for a small part of the budget devoted to innovative activities, that spending in R&D is extremely low. Industry constitutes a weak market for higher education scientific and technically trained personnel, a trend that was observed systematically for the first time in 1986 and has not changed until today, as seen in Table IV.

TABLE IV
COMPARISONS BETWEEN STT STAFF IN 1985-1987 AND 2001-2003

Size of firms	**% of firms without scientifically or technically higher education trained (STT) staff**	
	1985-1987 (1)	**2001-2003 (2)**
Small 20-49 for (1) <20 for (2)	73.8	87.4
Medium 50-99 for (1) 20-100 for (2)	50.3	63.2
Large > 100	22.5	21.9

Source: Argenti et al, 1988; Bianchi and Gras, 2006.

Table IV deserves some attention for three reasons. First, it gives information about a specific type of staff: that with higher education in science or technology. This type of information is gathered in some Latin American surveys; it is gathered too in several European surveys. In the Uruguayan case it has been collected in 1986, 2001 and 2003, even if with different methodologies. We posit that this is a positive feature of Uruguayan surveys that should be maintained and improved. Second, it depicts information for "not having staff with S&T higher education training". The important issue here is that "having" and "not having" this type of staff is not symmetrical in substantive terms for the whole population of firms, particularly regarding size but regarding sector too. The case of size is particularly clear: there is no linear relationship between size and number of S&T trainees in terms of capacity to relate usefully with knowledge. On the contrary, "not having" is a clear indicator of a capacity that is missing. A recent empirical work on small firms in Denmark shows exactly this: firms that hired their first university trained employee exhibited two years later a much higher propensity to introduce innovations than those firms that did not hire any [12].

Finally, this way of depicting information is useful for policy design. If the first university trainee in a small or medium firm seems to be able to make a difference in terms of its ability to interact with knowledge sources, then having a map of firms without such personnel allows to identify what can be called a "knowledge-vulnerable" population of firms. Specific policies for such population with special pro-active features can then be designed and tried.

Table V shows the distribution of professionals in Uruguayan industry by type of knowledge and activity within the firm: this type of information is also useful to have a better overall picture.

TABLE V
PROFESSIONALS BY FIELD OF KNOWLEDGE AND TYPE OF ACTIVITY
(Uruguay, 2001-2003)

Field of knowledge (as asked in the survey)	% of each type of professional in total professional staff	% of each type of professional engaged in R&D activities (1)	% of each type of professional engaged in other innovation activities (2)	(1) + (2)	% of each type of professional not engaged in any innovative activity	Total
Exact sciences (physics and chemistry)	17.0	29.5	50.1	79.6	20.4	100
Exact sciences (mathematics and statistics)	4.3	6.1	14.4	20.5	79.5	100
Natural sciences (biology, biochemistry, biophysics)	1.1	21.2	42.4	65.6	36.4	100
Medical sciences	5.8	5.1	11.4	16.6	83.4	100
Technology (engineering and architecture)	27.4	20.3	45.1	65.4	34.6	100
Agrarian sciences	11.8	17.8	28.6	46.5	53.5	100
Social sciences	28.5	3.0	10.3	13.3	86.7	100
Humanities	4.1	0	4.8	4.8	95.2	100
Total	100					

Source: Own elaboration based on IAS 2003

We will not undertake a thorough analysis of this table, but make brief comments related to the fields of knowledge with high scores in the column "% of each type of professional not engaged in any innovative activity", mathematics and statistics, medical sciences, social sciences and humanities. In the first case, it can be inferred that this type of professionals is engaged mainly in production and management; in the second case, such professionals are mainly hired to perform certification of personnel on leave for health reasons. The case of social sciences and humanities is more difficult to tackle. They could have been associated to "soft" innovations, but only one third of firms declared having performed innovation in organizational change and related issues, which may explain the very low attachment of such professionals to innovative activities. The main explanation seems to stem, then, from a general trend of the labor market present in Latin America during the so called neo-liberal reforms: "Firms have used educational and skills levels to select personnel not so much because they needed workers with higher schooling as because the overabundance of workers allows them to be more selective in hiring" [13].

On another vein, with this same data [14] made an statistical exercise with the aim of clustering firms around a set of characteristics related to the "cognitive base" of its innovative behavior. For this exercise "innovation activities" include R&D, design, quality control and engineering. A set of 20 variables were defined, associated with three features: the internal capabilities of the firm, the links that the firm maintains with its environment to undertake innovative activities, and the firm's innovation experience. Three patterns were defined, as shown in Table VI.

TABLE VI
INNOVATIVE BEHAVIOR PATTERNS IN THE URUGUAYAN MANUFACTURING INDUSTRY

Definition of the pattern	% of cases*
Low or null innovative intensity	73.4
Innovation based on exogenous knowledge (Mainly through purchasing capital goods).	13.7
Innovation based on the endogenous competences of the firm.	7.1

* 5.8% of the cases could not be analyzed based in the multivariate analysis.
Source: adapted from: Bianchi and Gras 2006

In terms of knowledge for innovation, one of such patterns, covering almost three quarters of all firms, is a "very weak demander"; the second one can be sketched as a "buy" pattern and the third as a "make" pattern.

The first pattern, characterized by low or null innovative intensity, includes 83% of firms that did not engage in any innovation activity. The reminding 17% of firms exhibiting this pattern did declare having carried out innovative activities. We have here a "data mismatch": 34.6% of firms counted as innovative by the survey belongs to the pattern of low or null innovative intensity.

The second pattern identifies firms whose innovative processes are based on the incorporation of exogenous knowledge. The innovation activities of these firms are basically oriented towards investments in hardware, software and capital goods. Both the first and the second pattern exhibit as a characteristic the low number of firms with engineers or scientifically trained personnel (see Table X).

The firms characterized by the third pattern exhibit a higher proportion of STT personnel as well as stronger linkages with agents of the NIS. They are a fair minority in the Uruguayan industrial landscape.

The analysis of the behavior of the three groups of firms in relation to cooperation understood as links with NIS agents, further confirms the importance of seeing cooperation as knowledge exchanges driven by people. This analysis is done in two steps. First, as shown in Table VII, cooperation is taken as a broad concept; second, as shown in Table VIII, cooperation is taken in a more detailed way.

TABLE VII
INNOVATIVE BEHAVIOR PATTERNS AND LINKS WITH NIS AGENTS*
(% of firms)

Links with NSI institutions	Low or null innovative intensity	Innovation based on exogenous knowledge	Innovation based on the endogenous competences of the firm	Total
No	42.46	22.00	8.78	36.96
Yes	57.54	78.00	91.22	63.04
	100.00	100.00	100.00	100.00

Source: Adapted from Bianchi and Gras, 2006.
* NIS agents include universities, technological centers, technical training institutes, laboratories, technological-related units, financial bodies, suppliers, customers, related enterprises, other enterprises, consultants, S&T government agencies and the firm's headquarters.

TABLE VIII
INNOVATIVE BEHAVIOR PATTERNS AND DETAILED LINKS WITH NIS AGENTS*
(% of firms)

		Low or null innovative intensity	Innovation based on exogenous knowledge	Innovation based on endogenous competence of the firm	Total
Links for R&D	No links	98.59	93.25	67.80	95.51
	Links with one institution	1.41	2.50	17.56	2.77
	Links with more than one institution	0.00	4.25	14.63	1.72
Links for other innovation activities*	No links	70.40	42.50	27.18	63.08
	Links with one institution	16.58	9.50	12.14	15.21
	Links with more than one institution	13.02	48.00	60.68	21.71
Links for training	No links	90.91	51.88	51.96	82.32
	Links with one institution	6.00	24.06	23.04	9.90
	Links with more than one institution	3.09	24.06	25.00	7.78
Links for financing	No links	78.37	71.93	67.80	76.64
	Links with one institution	16.15	22.81	14.63	17.01
	Links with more than one institution	5.48	5.26	17.56	6.35

Other innovation activities include organizational change; testing; technical support; and design.
Source: Adapted from: Bianchi and Gras 2006.

Each pattern behaves as it is reasonable to expect it would: the low intensity pattern has very little cooperation, diminishing as the type of cooperation is more knowledge intensive, and the endogenous innovative pattern has relatively high cooperation in comparison to the other patterns, the difference widening as the type of cooperation is more knowledge intensive.

It is worth presenting a last piece of data stemming from the IAS 2003 survey. How many of the firms declaring performing R&D did not have any STT employee? The figure is high indeed: 54.5%. It is compelling, then, to criticize the data, trying to understand how it can be that almost one third of all firms declaring being innovative are in fact not innovative, and more than half of the firms declaring performing R&D have not a single employee with some training at university level in sciences or engineering.

The problem lies with the concepts used and with the questionnaires utilized. We are not alone in criticizing the concepts used in innovation surveys. Referring to the European innovation surveys and its estimation of innovative firms, it has been recently said: "…a broad all-encompassing definition of innovation is both misleading in international comparisons and also fails to provide a clear picture of the structure of innovation capabilities within individual countries" [8]. If this is true for Europe, it is even more so when innovation surveys refer to a developing country. In such a context, both concepts and the way of making questions need to be carefully revisited to obtain meaningful results. Elsewhere [15] some of these issues have been discussed. It is worth to recall here that firms that declare being innovative while they are not, can do that not only because the concept of innovation is not well described, but because they want to be seen in a better light. Innovation is a value laded concept: to innovate is good and not innovating is not good, and so answers to this question should not be taken at face value. This suggests that innovation surveys should be prepared and analysed taking on board the expertice of diverse social scientists.

The suggestion is in fact more demanding. The very comprehension of innovation as a complex social process leads to revisit the articulation between innovation theory and the tools designed to measure innovation [16].

Let's come back now to the overall picture on innovation that can be gathered linking the different exercises made with the sources of information available. Knowledgeable people and what they know at firm level is key for cooperation. They share a specialized knowledge that allows them to recognize each other in the first place, to set a common agenda of exchanges in the second place, and finally to establish cooperation relationships. We knew that beforehand, less from theory than from common sense. However, confirmation coming from innovation surveys analysis suggests that digging further in this direction can be of value.

Descriptive statistics, cluster analysis enriched by econometric models, case studies and the general knowledge about the Uruguayan economy, help to formulate questions to data from different perspectives, making that way the best possible use of the wealth of information that innovation surveys usually convey. They help also to realize which questions that appear as important are not answerable due to weaknesses in the way innovation surveys are conceived, which helps to advocate for changes that should be made in the design of such surveys.

IV. A Survey Example To Take Into Account

Reference [17] is interesting for two main reasons: the type of questions included and the factorial analysis made, leading to a clustering that can be compared with the Uruguayan one presented in this paper.

The typology of firms developed by FE applying a factorial analysis to 11 variables taken from the questionnaire led to 5 categories or patterns:

1 "small, local, static" (30% of the sample): "do not invest in efforts to support (innovation) activity through hiring new graduates, training their staff or participating in an innovation network."
2 "local dynamic" (13% of the sample) "can be considered to be innovative...When it comes to supporting their innovative activities, this group looks to experts for advice on innovation, they hire new national graduates, train their personnel and participate in an innovation network."
3 "exporting, non-innovative" (24% of the sample) "are equally inactive in terms of efforts to support innovation activities including engaging the services of experts in the matter, hiring new graduates and training staff."
4 "successful, innovative" (20% of the sample) "This group of companies shines in all aspects of the innovative process and support this activity through the requesting of advice from experts as well as hiring new graduates from universities at home and abroad."
5 "secure, public sector clients" (13% of the sample) "Their distinguishing characteristic is that they sell to a number of government agencies".

Table IX shows selected information about the behavior of the FE patterns. Table X shows how the patterns in the Uruguayan case relate to several innovation issues: its last column exhibit data of the FE "successful, innovative" pattern to compare.

TABLE IX
SELECTED INFORMATION FROM FLASH EUROBAROMETER (FE) Nº 164
(% of firms of each type that answered yes)

Questions	1 "small, local, static"	2 "local dynamic"	3 "exporting, non-innovative"	4 "successful, innovative"	5 "secure, public sector clients"
Successfully introduce new or significantly improved products or services.	60.5	84.5	74.1	88.4	75.8
Carry out in-house research	33.2	74.6	50.4	70.9	51.4
Contract out research to other firms, universities or research institutes..	6.4	26.8	11.3	46.1	17.2
In the last two years, did you obtain public support for R & D within your firm or for R & D contracted out to other organizations?	6.4	14.1	10.2	28.5	12.3
In the last two years, did you obtain advice services for your innovation activities e.g. with business plans, market research, patenting, finding innovation partners, or adopting new manufacturing technology?	5.9	63.4	15.3	45.1	26.1
In the last two years, in support of your innovation activities, did any of your staff attend formal training courses?	46.2	90.1	54.9	73.7	65.5
In the last two years, did your firm participate in an innovation network including other firms, universities, or research institutes	3.4	18.5	2.8	35.9	11.5
Was public support in the last two years crucial to any of your innovation projects, such that the innovation would not have been developed without the support? (for those receiving public support)*	19.0	22.4	19.3	32.9	13.8
In the last two years, in support of your innovation activities, did your firm hire one or more new university graduates from the following countries? Your country	16.3	44.4	28.1	55.8	26.1

TABLE X
INNOVATIVE BEHAVIOR PATTERNS IN THE URUGUAYAN MANUFACTURING INDUSTRY BY SEVERAL CHARACTERISTICS OF INTEREST

	Low or null innovative intensity	**Innovation based on exogenous knowledge**	**Innovation based on endogenous competence of the firm**	Total in each row	Type 4 for FE
All sample	73.4	13.7	7.1	100	
For Innovative TPP					
Innovative TPP	33.9 (13.0)*	43.6 (89.0)	22.5 (89.8)	100	88.4
Internal R&D	8.8 (10.5)	55.3 (51.1)	35.9 (64.1)	100	70.9
Public support for innovation(only 3 innovative TPP firms)	0.0	66.7 (0.6)	33.3 (0.5)	100	28.5
Links fo R&D with S&T institutions	2.6 (0.7)	30.3 (6.5)	67.1 (27.7)	100	
Links for R&D with other firms	0.0	13.8 (1.1)	86.2 (13.6)	100	
With professionals	24.8 (33.9)	39.3 (41.8)	35.9 (73.2)	100	
With STT professionals	19.6 (18.4)	30.0 (21.9)	50.4 (70.8)	100	
Obstacle for innovate with high rating: scarcity of qualified personnel	18.5	56.7	24.8	100	

Source: Own elaboration based on IAS 2003
* (xxx) indicates the proportion of firms in each pattern that have the characteristic indicated in the row.

V. SOME IDEAS FOR THE FUTURE BASED ON THE MAIN RESULTS

We proposed, as a point of departure, that cooperation for innovation may be understood as a knowledge exchange. This implies that it is a process mainly driven by people through interaction, which involves a good deal of tacit knowledge. In this sense, it is key to know who knows what -and do what- in the firms.

Following this approach, we highlighted why some aspects of the innovation surveys are unsatisfactory for analyzing the cooperation activities of firms. These aspects are related to (i) the ways of taking into account and of analyzing "absorptive capacities" [18] and (ii) the ways of asking for innovation and for R&D activities.

We analyzed the absorptive capacities of the firms by inquiring who knows what, and do what, using for that inquiry the available data in the IAS 2003 and in other innovation databases. The best available proxies for that aim are (i) the presence of professionals in the firms' staff and (ii) the kind of professionals that are hired by the firms. Based on that, we tried to answer several questions using different methods for "interrogating" data, including multivariate analysis and a thorough revision of descriptive results. We checked too our results with other international sources. The main convergent result achieved is that having knowledgeable people discriminates clearly between firms that cooperate for innovation and are involved in relatively complex innovation tasks and those that do not. This is shown in Table XI.

TABLE XI
COMPARING FIRMS' BEHAVIOR WITH AND WITHOUT PROFESSIONALS

More than 60% of firms that do have professionals	**More than 60% of firms that do not have professionals**
Spend on R&D	Do not spend on R&D
Perform R&D	Do not perform R&D
Cooperate for R&D	Do not cooperate for R&D with S&T institutions
Cooperate for R&D with S&T institutions	Do not cooperate for R&D with other firms
Cooperate for R&D with other firms	
Cooperate for training	

Source: Own elaboration from IAS 2003

However, to better understand the innovation dynamics and to derive policy advise we need to know better:

i) The universe of innovative firms, by taking into account innovative activities in very diverse forms and by making sure that the answers are accurate. In order to achieve this, it is necessary not to treat innovation as a free-value concept; a multidisciplinary approach is needed to build better questionnaires.
ii) Who knows what and do what at firm level, in order to asses present and future cooperative behavior. New questions about organizational topics are also important in order to assess the opportunities to be creative opened by the firms.
iii) The "knowledge weak" actors, those with bad prospects of having a strong innovative and cooperative behavior.

To better link innovation analysis to innovation policy design a good approach would be to ask what are the realms where innovation policy can really make a difference and devise indicators to better know how firms behave in relation to such issues. A good example is co-operation, because it is critically important and because it is a field where significant improvements in the ambience where actors interact and take decisions can be induced by policy action. If co-operation is a main focus of attention, the issue of who co-operates with whom is a fundamental concern. Knowledgeable people in the organization (knowledgeable at all levels and types of knowledge) appears as a main piece of the needed information, followed by a detailed description of what they know today, key to understand both the scope of what they can absorb today and what they can arrive to know tomorrow. Interactions with research and teaching institutions are important to fine-tuning life-long learning associated with changing demands in the productive sector, so better questions about these interactions should be devised. The suggestion here is not to put innovation

surveys up-side-down and take exclusively into account considerations of this sort, but to assure that some room is made to integrate them.

The task is not easy; it requires that mono-disciplinary approaches to innovation be surpassed. Freeman made many years ago a strong plea for interdisciplinary work, particularly to understand the role of science and technology in social change, that conserves all its validity today: "Neither sociologists, nor economists, nor political scientists have satisfactory theories of social change and it is unlikely that they will developed them unless they overcome their fragmentation into separate jealously guarded kingdoms and learn to cooperated with each other and with natural scientists…" [19]. We posit that everywhere, but particularly so in developing countries, Freeman's recommendation should be seriously taken into account. Next generation of innovation surveys should then be the result of cooperative efforts of different people, knowing different things and willing to help change to happen.

REFERENCES

[1] R.R. Nelson and S. G. Winter "An Evolutionary Theory of Economic Change". Harvard Univ. Pres, Cambridge, 1982.

[2] B. Johnson "Institutional learning", in Lundvall, B. A (Ed) National Systems of Innovation - Towards a Theory of Innovation and Interactive Learning, Pinter Publishers, London, pp 23-41, 1992.

[3] R. Rothwell "Factors for Success in Industrial Innovations: Project SAPPHO – A Comparative Study of Success and Failure in Industrial Innovation". Science Policy Research Unit, University of Sussex, Brighton, 1972.

[4] B.A. Lundvall "Product innovation and user-producer interaction". Industrial Development Research Series, Nº 31, Aalborg University Press, Aalborg, 1985.

[5] E. von Hippel "The sources of innovation". Oxford University Press, 1988.

[6] B. Jepessen and M. Molin "Consumers as Co-developers: Learning and Innovation Outside the Firm", Technology Analysis & Strategic Management 15: 3, pp 363-383, 2003.

[7] R. Lund and A.N. Gjerding "The flexible company Innovation, work organisation and human ressource management". DRUID Working Paper N° 96-17, Aalborg University, Denmark, 1996.

[8] A. Arundel, E. Lorenz, B. A. Lundvall, and A. Valeyre "Organizational Forms and Innovative Performance: a comparison of the EU-15". DRUID Working Paper N° 06-14, Aalborg University, Denmark, 2006.

[9] A. Arundel "Innovation Surveys and Policy: Lessons from the CIS, in Technology Policy Briefs", Volume 4, Issue 1, Maastricht, 2005.

[10] C. Bianchi, N. Gras and J. Sutz "Make, buy and cooperate in innovation: evidence from Uruguayan manufacturing surveys and other innovation studies". ECLAC-IDRC project, 2009.

[11] B. Baptista "Indicadores de Innovación en Uruguay (1998-2000): Balance Metodológico y Principales Resultados Empíricos". Paper presented to the X Seminario Latino Iberoamericano de Gestión Tecnológica ALTEC 2003, RICYT Workshop on Innovation Indicators, Mexico DF, 2003.

[12] R. Nielsen "Human resources in innovation systems, with focus on introduction of highly educated labour in small Danish firms", PhD Thesis, February , Department of Business Studies, Aalborg University, Denmark, 2007.

[13] L. Reygadas "Latin America: persistent inequalities and recent transformations" in Hershberg, E. and Rosen, F. (Eds) Latin America After Neoliberalism. NACLA (North America Congress on Latin America), The New Press, New York, 2006.

[14] C. Bianchi and N. Gras "Innovative behavior and economic performance in the Uruguayan Manufacturing Industry 2001-2003". Paper presented at the International ProACT Conference, Innovation Pressure, Tampere, Finland, 2006.

[15] J. Sutz "Building accurate mirrors: innovation indicators for better innovation policies in underdevelopment", paper presented at the Workshop on Innovation Indicators, "Catch-Up Group" Meeting, PREST, Manchester, 2006.

[16] J. E. Cassiolato, H. M. M. Lastres and M. L. Maciel "Systems of Innovation and Development". Edward Elgar. Cheltenham, UK, 2003.

[17] European Commission. Flash Eurobarometer N° 164, 2004.

[18] W.M. Cohen and D. A. Levinthal "Absorptive Capacity: a New Perspective on Learning and Innovation". Administrative Science Quarterly 35 (1): pp 128–52, 1990.

[19] C. Freeman "Malthus with a computer", in Teich. A. (Ed) Technology and Man's Future, St. Martin's Press, New York, pp 82-97, 1977.