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R&D Collaboration Networks in Spain

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This paper is the first draft of a series of analysis conducted within the inter-firm collaboration focus group of the OECD/NIS project. Its aim is to provide a basic framework for our understanding of the empirical issues tackled on inter-firm collaboration and more precisely on product development collaboration.

The specific target of the activities conducted by the focus group has been to develop comparative knowledge, between different countries, on the way that firms related one each other and interact in the innovation process. Since there is not a single tool, at international level, for conducting such specific analysis, our major interest was in developing and implementing a survey on product development collaboration based on the DISKO questionnaire, previously implemented by the lead country (Denmark).

The strategy followed by the Spanish team has been two-fold: First, to generate a basic frame for understanding the concrete empirical issue to be tackle with a new survey. In order to accomplish such task we decided to analyze in deep the results of the first systematic and accurate measure of the innovation in Spanish firms: the 1994 Technological Innovation survey (Encuesta sobre Innovación Tecnológica en las Empresas 1994).

Secondly, to contribute to the preparatory works of the new ad hoc survey on "product development collaboration". In this domain most of the Spanish action has attempted to increase the comparability of the draft questionnaire proposed by our Danish colleagues. At the time of preparation of the first draft of this document the negotiation of the final core questions of the new version of the "product collaboration questionnaire" is almost over, but still we did not have started the process of implementation of the questionnaire to the firms. Fieldwork of the Spanish survey will be develop in January 1998.

Because of the planning of our research activities, most of the content of this draft report refers only to the information and analysis linked to the first approach taken to the problem of innovation collaboration, and based in the Spanish Innovation survey.

I. The Innovative Patterns of the Spanish Firms (*The Innovation Survey*, 1994)

What it will be reported here refers to the results of the 1994 Innovation Survey carried out by the Spanish Instituto Nacional de Estadística (INE).

1. General Issues

The previous 1992 innovation survey, launched at the time of the first round of Community

Innovation Survey, failed during the implementation process because it was stopped. Hence, this firs attempt only contains a relative and biased small number of questionnaires (2.400).

The process and the results of this first exercise had been interpreted by the INE as a first test or pilot study, and no publication or reported data had been offered. No matter that some of the statistic official had reported some of the results (see Angulo, 1995).

The design of the sample for the 1994 Innovation Survey followed a "representative" strategy of random stratified sampling, based in industry and employment size. A total sample of 10.000 firms was selected, including a sub-group of population with all (probability = 1) the Spanish firms that perform I+D (approx. 1200), and all the firms of 200 or more employees. Valid questionnaires collected were approximately 7.500.

The basic classificatory data on the innovative behavior of the firms refer to the realization of innovative activities for the development or introduction of either product and process innovations; time frame is the period 1992-1994. Additional information basic for the analysis such employment, total sales, exports, innovation expenditures, R&D cooperation, etc. refers mostly to 1994.

For all the description of the elevation coefficients, margins of error, etc. please referred to the original publication : Instituto Nacional de Estadística (1997): *Encuesta sobre Innovación Tecnológica en las Empresas 1994*. Madrid: INE, 1997.

2. Questions on "Collaboration" of the Spanish Innovation Survey

There are four **core** questions of the 1994 Spanish Innovation survey that may be taken as a proxy of collaboration, or more precisely, of interaction between actors in the innovation process, though only one opens the possibility of making a deep analysis on the interactions between agents located in different geographical areas.

The question (Q.5.6 in the original questionnaire) has been posed in the following terms: *"Have your company cooperated with other institutions in R&D projects during 1994?"*. If the answer is YES then becomes the identification of the "actors" and their "geographical" location. The population of answers come only from the firms that had been identified as "innovative".

There are other three questions that refers to "technology acquisition", "technology transfer", and "participation in R&D programs". Data elaborated from such set of questions show different types of interactions but did not allow to identified with which type of actors.

3. General Results of the Spanish Innovation Survey

Spanish innovative firms represent 10,7 % of the total population of industrial firms. More than 17.000 firms developed, between 1992-1994, activities conductive to product or/and process innovation. A similar number of non-innovative firms mentioned their intentions to do innovative activities in the near future, between 1995-1997. Most of the innovative firms (60%) developed activities for product and process innovations, while only 20% developed products innovations and another 20 % only process innovations.

The main conclusions are the following. First, that size is positive correlated with the involvement in innovative activities. Seven out of ten firms with 200 and more employees are innovative. Second, there is also a positive correlation between industry and innovation. The most innovative (more than 40 % of firms are innovative) are "manufacturing of telecommunication equipment", "pharmaceuticals" and "oil transformation".

Spanish firms invested in "innovative activities" during the year of reference (1994) approximately 620.000 millions Ptas, that represents 1 % of the GDP, and approximately 4,8 percent of the manufactured gross value added. Total expenditures in R&D (internal and external) represents only 43 % of the total innovation expenditures. This figure is clearly below the European average of 50 %, in 1992. R&D expenditures of Spanish firms have also experienced a dramatic reduction in 1994 according to data of previous years.

Focusing on the group of innovative firms it is worth noticing that almost 25% develop R&D activities, while R&D is also positive and strong correlated with size, 77% of the firms of more than 200 employees perform R&D activities. A total of 4.360 Spanish companies conducted some R&D activities, but only 40 % of them (1.783 firms) can be characterized by systematic R&D activities, however represent 95 % of the total internal R&D expenditures of firms. (Tables 1 and 2 offers the general parameters of the results of the Spanish Technological Innovation Survey for 1994).

Finally, it rests to mention that the elevation factors used may introduce significant differences, by size and industry, in the standard errors. This is more clear for the results referring to firms of less than 20 employees.

T1. SPANISH INDUSTRIAL FIRMS IN RELATION TO INNOVATION BY SIZE (EMPLOYMENT). 1994

Size of firms	Manufacture firms		Innovative firms		R&D performing firms		Firms with R&D Department		
	Total	*%*	*Total*	*% Firms*	*Total*	*% Innovative*	*Total*	*%*	*% R&D firms*
Total	163.237	100	17.483	10,71	4.360	24,94	2.975	100	68,23
Less than 5	83.409	51,10	3.712	4,45	328	8,83	175	5,88	53,35
From 5 to 19	61.703	37,80	8.422	13,65	1.511	17,94	943	31,70	62,41
From 20 to 49	12.666	7,76	2.863	22,61	945	33,01	570	19,16	60,32
From 50 to 199	4.312	2,64	1.688	39,15	962	56,97	758	25,48	78,79
200 and more	1.147	0,70	799	69,61	614	76,94	529	17,78	86,16

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.
Note.- Because the elevation factors used the firms of less than 20 have a high margin of error that could produced misinterpretations.

T2. SPANISH INDUSTRIAL FIRMS IN RELATION TO INNOVATION BY INDUSTRY. 1994

Industry	Manufacture firms		Innovative firms			R&D Performing firms			Firms with R&D Department	
	%	*Total*	*%*	*Total*	*% Firms*	*%*	*Total firms*	*% Innov.*	*Total firms*	*% R&D*
TOTAL	100,00	163.237	100,00	17.483	10,71	100,00	4.360	24,94	2.975	68,23
10,11,12,13,14	0,97	1.591	0,87	152	9,58	0,64	28	18,28	14	50,00
15	17,95	29.299	25,96	4.538	15,49	9,66	421	9,27	380	90,26
16	0,01	22	0,04	7	31,82	0,11	5	71,43	5	100,00
17	3,97	6.479	2,71	473	7,3	5,14	224	47,33	204	91,07
18	6,94	11.332	4,00	700	6,18	1,33	58	8,29	26	44,83
19	3,48	5.687	0,90	158	2,78	0,46	20	12,86	16	80,00
20	9,27	15.136	4,12	720	4,76	2,66	116	16,08	9	7,76
21	1,06	1.724	1,20	210	12,18	1,90	83	39,42	44	53,01
22	7,21	11.765	6,37	1.113	9,46	0,37	16	1,48	7	43,75
23	0,01	17	0,04	7	41,18	0,11	5	71,43	5	100,00

24 (less 24.4)	1,89	3.079	4,95	866	28,13	11,06	482	55,6	441	91,49
24.4	0,25	416	1,03	180	43,38	2,98	130	71,83	125	96,15
25	2,91	4.748	4,94	864	18,21	8,03	350	40,52	118	33,71
26	5,78	9.432	7,28	1.273	13,5	6,10	266	20,93	251	94,36
27 (less 27.4)	0,61	999	0,61	107	10,68	1,15	50	47,04	36	72,00
27.4	0,26	419	0,38	66	15,82	0,62	27	40,02	21	77,78
28	15,54	25.359	12,46	2.179	8,59	6,17	269	12,34	160	59,48
29	5,93	9.687	6,88	1.202	12,41	12,64	551	45,82	300	54,45
30	0,05	82	0,11	20	24,36	0,34	15	75,58	15	100,00
31	1,69	2.758	2,75	480	17,41	6,77	295	61,46	177	60,00
32.1	0,25	408	0,72	126	30,87	2,06	90	71,56	71	78,89
32.2, 32.3	0,16	258	0,67	118	45,76	2,22	97	82,4	88	90,72
33	1,14	1.858	2,26	395	21,23	5,71	249	63,1	207	83,13
34	0,87	1.427	1,77	310	21,72	3,53	154	49,59	104	67,53
35.1	0,57	926	0,34	59	6,39	0,34	15	25,26	1	6,67
35.3	0,03	45	0,09	16	34,72	0,25	11	68,8	7	63,64
35.2, 35.4, 35. 5	0,07	121	0,20	35	28,69	0,60	26	75,14	16	61,54
36.1	8,10	13.229	4,74	829	6,27	3,78	165	19,89	44	26,67
36 (less 36.1)	2,25	3.665	1,05	183	4,99	2,39	104	57,01	62	59,62
37	0,12	198	0,06	10	5,16	0,11	5	48,37	2	40,00
40	0,66	1.071	0,48	84	7,86	0,78	34	40,04	21	61,76

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.

4. R&D Collaboration in Spanish firms

The innovation survey shows that 40 % of the firms that performed R&D in 1994, also developed R&D projects in collaboration with other partners and institutions (see tables 3, 4 and 5).

Intensity of collaboration measured as the % of firms doing R&D in collaboration in relation to the total number of firms doing R&D at industry level, is higher (>60%) in "traditional sectors" and "high tech industries". Instruments, pharmaceuticals and aerospace are in the latter category, while wood transformation, furniture, manufacturing of paper and cardboard, etc. that are part of the traditional manufacturing base of the country owns to the former. A singular group that exhibit high levels of intensity in R&D collaboration is also formed by big manufacturing companies from tobacco, electricity, gas and water supply. (The elevation factors of some traditional sectors could in part explain this data).

The main difference between high-tech and low-tech or traditional sectors comes from the average number of partners, and the type of partner. High-tech firms exhibit a large number of partners (i.e. 3,3 in aerospace) as result of increasing intensity and R&D diversification. Low-tech or traditional industries in contrast have a small number of partners, often only one. In spite of such differences what is of major relevance is the different nature and role of partners and collaborators. In traditional industries links with suppliers and customers are the most widespread form of collaboration.

The average number of R&D partners is also positive correlated with size. Firms with 200 and more employees have a greater number of R&D partners (2,8) while the average number for the whole population is two.

The major conclusion of this analysis is that the most relevant partner of business firms are other business firms, either suppliers, customers or competitors. Collaboration with suppliers and customers is crucial as the figures show (35% of the firms that cooperate in R&D). Equally relevant is the role played by consultancy firms in the process of R&D

collaboration and diffusion. Around 27 % of the firms have a the cooperative link established with "experts and consultancy companies". Finally, in almost 20 % of the cases companies cooperate with firms within the same group.

It is very relevant that little R&D cooperation is developed with competitors and through joint ventures, however also big firm use this two partners much more that the small ones.

Universities and public research centers also play a relevant role as partners for R&D cooperation. Spanish firms cooperate in R&D with universities and research centers: 32 % of the firms have universities as partners, 25 % public research centers and 14 % centers from "research associations". In this case, size is also positive correlated with having universities or research centers as partners of the R&D collaboration.

The location of the R&D cooperative partners is mostly concentrated in Spain, followed by the EU countries and the United States. 70 % of the total number of partners in the R&D collaboration that firms have are from Spain. The other 30 % is distributed in a 20% for European partners and 5 % for USA partners.

Interesting is to mention the fact that, in some categories or specific types of collaboration, Spanish firms have a higher number of non-Spanish partners than of domestic partners. That is the case of collaboration within the same group, competitors and joint ventures. However, the singular case comes from the fact that only 64 % of the firms that confirmate R&D cooperation with universities they do with Spanish Universities, while 76% of the firms that have R&D cooperation, at least they have one Spanish partner.

T3a. SPANISH INNOVATIVE FIRMS PERFORMING R&D BY R&D COOPERATION AND INDUSTRY. 1994

Industry	R&D performing firms					
	Total	*Non collabor*	*Collabor*	*% R&D collabor*	*Total # partners*	*Average partn/firm*
TOTAL	4.360	2623	1737	39,84	3490	2,01
10,11,12,13,14	28	18	10	35,71	35	3,50
15	420	297	123	29,29	267	2,17
16	5	2	3	60,00	6	2,00
17	223	118	105	47,09	245	2,33
18	58	55	3	5,17	5	1,67
19	20	12	8	40,00	14	1,75
20	116	18	98	84,48	102	1,04
21	83	31	52	62,65	105	2,02
22	16	13	3	18,75	6	2,00
23	5	2	3	60,00	11	3,67
24 (less 24.4)	482	272	210	43,57	441	2,10
24.4	130	51	79	60,77	214	2,71
25	350	272	78	22,29	131	1,68
26	267	139	128	47,94	199	1,55
27 (less 27.4)	51	24	27	52,94	71	2,63
27.4	26	18	8	30,77	23	2,88
28	269	189	80	29,74	186	2,33
29	551	376	175	31,76	355	2,03
30	15	10	5	33,33	8	1,60
31	295	207	88	29,83	136	1,55
32.1	90	69	21	23,33	42	2,00
32.2, 32.3	97	64	33	34,02	67	2,03
33	249	86	163	65,46	340	2,09
34	154	88	66	42,86	168	2,55

35.1	15	11	4	26,67	13	3,25
35.3	11	4	7	63,64	23	3,29
35.2, 35.4, 35. 5	26	16	10	38,46	21	2,10
36.1	165	52	113	68,48	142	1,26
36 (less 36.1)	105	91	14	13,33	20	1,43
37	5	3	2	40,00	6	3,00
40	33	13	20	60,61	77	3,85

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.

T3b. SPANISH INNOVATIVE FIRMS PERFORMING R&D BY R&D COOPERATION AND INDUSTRY. 1994

Industry	Percentage of the R&D firms that collaborate with in R&D for any of the partners categories (% Hor)										
	R&D collab firms	*Firms same group*	*Custom-ers*	*Supplier*	*Compe-titors*	*Joint-ventures*	*Experts consult*	*R&D As-sociation*	*Pub. R&D Centers*	*Univ.*	*Others*
TOTAL	1.737	336	607	622	81	87	469	246	431	554	57
(Horizontal %)		19,34	34,95	35,81	4,66	5,01	27,00	14,16	24,81	31,89	3,28
10,11,12,13,14	10	30,00	20,00	20,00	20,00	10,00	60,00	70,00	40,00	70,00	10,00
15	123	34,96	28,46	16,26	2,44	2,44	13,01	25,20	28,46	48,78	17,07
16	3	33,33	66,67	0,00	33,33	0,00	33,33	0,00	0,00	33,33	0,00
17	105	13,33	82,86	91,43	0,95	16,19	16,19	1,90	2,86	7,62	0,00
18	3	0,00	0,00	33,33	33,33	0,00	33,33	0,00	0,00	66,67	0,00
19	8	12,50	12,50	62,50	0,00	0,00	25,00	25,00	12,50	12,50	12,50
20	98	1,02	1,02	1,02	0,00	0,00	1,02	2,04	97,96	0,00	0,00
21	52	19,23	32,69	78,85	1,92	1,92	19,23	5,77	15,38	23,08	3,85
22	3	0,00	0,00	33,33	0,00	0,00	0,00	33,33	33,33	66,67	33,33
23	3	66,67	33,33	33,33	33,33	33,33	33,33	33,33	66,67	33,33	0,00
24 (less 24.4)	210	20,00	60,00	13,81	4,29	11,90	19,05	16,67	30,95	32,38	0,95
24.4	79	43,04	20,25	6,33	7,59	6,33	30,38	18,99	53,16	70,89	13,92
25	78	28,21	42,31	33,33	8,97	1,28	17,95	6,41	17,95	11,54	0,00
26	128	11,72	59,38	21,09	3,91	2,34	14,06	14,06	12,50	14,84	1,56
27 (less 27.4)	27	40,74	33,33	33,33	7,41	3,70	7,41	40,74	44,44	48,15	3,70
27.4	8	12,50	25,00	12,50	25,00	0,00	50,00	37,50	50,00	75,00	0,00
28	80	6,25	33,75	63,75	23,75	6,25	15,00	27,50	30,00	23,75	2,50
29	175	22,29	20,57	54,29	1,71	2,29	49,14	16,00	14,86	20,00	1,71
30	5	60,00	60,00	0,00	0,00	0,00	0,00	20,00	0,00	20,00	0,00
31	88	21,59	62,50	15,91	0,00	2,27	13,64	4,55	13,64	20,45	0,00
32.1	21	4,76	52,38	42,86	4,76	4,76	23,81	9,52	19,05	38,10	0,00
32.2, 32.3	33	24,24	30,30	15,15	9,09	6,06	15,15	6,06	42,42	51,52	3,03
33	163	5,52	8,59	5,52	3,07	0,61	82,82	5,52	6,75	88,34	1,84
34	66	48,48	40,91	66,67	3,03	4,55	36,36	9,09	15,15	30,30	0,00
35.1	4	25,00	0,00	25,00	25,00	0,00	100,00	25,00	50,00	75,00	0,00
35.3	7	28,57	42,86	42,86	14,29	14,29	28,57	28,57	57,14	71,43	0,00
35.2, 35.4, 35. 5	10	30,00	40,00	50,00	10,00	10,00	20,00	10,00	20,00	20,00	0,00
36.1	113	0,88	3,54	95,58	0,00	0,00	10,62	11,50	1,77	0,88	0,88
36 (less 36.1)	14	21,43	7,14	7,14	0,00	7,14	35,71	21,43	21,43	7,14	14,29
37	2	0,00	0,00	50,00	0,00	100,00	0,00	0,00	100,00	50,00	0,00
40	20	50,00	15,00	55,00	15,00	15,00	35,00	70,00	45,00	75,00	10,00

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.

T4. SPANISH INNOVATIVE FIRMS PERFORMING R&D BY R&D COOPERATION AND SIZE (EMPLOYMENT). 1994

Size by employment	R&D performing firms

	Total	*Non R&D collaboration*	*R&D collaboration*	*% R&D collaboration*	*Total partners*	*Average partners/firm*
TOTAL	4.360	2623	1737	39,84	3490	2,01
Less than 5	328	196	132	40,24	263	1,99
From 5 to 19	1.511	924	587	38,85	839	1,43
From 20 to 49	945	688	257	27,20	535	2,08
From 50 to199	962	552	410	42,62	869	2,12
200 and more	614	263	351	57,17	982	2,80

Size by employment	**% of the R&D firms that collaborate with in R&D for any of the partners categories (% hor.)**										
	R&D firm collabor.	*Firms same group*	*Custom-ers*	*Supplier*	*Compe-titors*	*Joint-ventures*	*Experts consult*	*R&D As-sociation*	*Pub. R&D Centers*	*Univ.*	*Others*
TOTAL	1737	19,34	34,95	35,81	4,66	5,01	27,00	14,16	24,81	31,89	3,28
Less than 5	132	0,00	3,79	1,52	0,00	0,00	**96,21**	0,00	1,52	**96,21**	0,00
From 5 to 19	587	0,51	**48,04**	**44,46**	0,00	2,56	15,50	3,24	22,32	5,79	0,51
From 20 to 49	257	17,12	38,52	44,75	9,34	7,78	21,01	6,61	19,07	35,02	8,95
From 50 to 99	410	30,49	30,98	32,44	4,63	4,88	26,83	26,10	25,61	27,32	2,68
200 and more	351	**46,44**	26,78	31,91	10,83	8,83	24,79	**29,34**	**41,03**	**54,42**	5,41

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.

Note.- Because the elevation factors used the firms of less than 20 have a high margin of error that could produced misinterpretations.

T5. SPANISH INNOVATIVE FIRMS PERFORMING R&D BY R&D COOPERATION AND LOCATION OF PARTNER. 1994

	Percentage of the R&D firms that collaborate with in R&D for any of the partners categories in any geographical location (% hor.)											
	R&D firms collab.	*Total # partners (% vert)*	*Firms same group*	*Custom-ers*	*Supplier*	*Compe-titors*	*Joint-venture*	*Experts consult*	*R&D As-sociation*	*Pub. R&D centers*	*Univ.*	*Others*
TOTAL	1737	3490	336	607	622	81	87	469	246	431	554	57
(% horizontal)			19,34	34,95	35,81	4,66	5,01	27,00	14,16	24,81	31,89	3,28
Spain	1331	*76,63*	76,49	79,74	86,17	88,89	89,66	67,38	88,62	89,33	64,44	92,98
Other EU	389	*22,39*	50,30	19,44	26,29	32,10	35,63	21,96	33,74	26,45	25,63	28,07
Rest Europe	49	*2,82*	8,33	4,28	3,70	6,17	3,45	3,41	4,88	3,94	3,43	5,26
USA	103	*5,93*	12,50	5,93	4,66	17,28	10,34	5,76	10,98	8,58	8,30	15,79
Japan	49	*2,82*	7,74	2,47	3,22	6,17	6,90	4,05	4,07	3,94	3,61	3,51
Rest World	18	*1,04*	2,68	0,99	1,13	3,70	4,60	2,35	0,81	1,62	2,35	1,75
Total % diversity		111,6	158,0	112,9	125,6	154,3	150,6	104,9	143,1	133,9	107,8	147,4

Source: INE: *Encuesta sobre innovación tecnológica en las empresas, 1994*. Madrid: INE, 1997.

Annex: Industry classification used

NACE Divisions	**Sectores Industriales**	**Industries**
10,11,12,13,14	Extractivas	Mining and extractive
15	Alimentación, bebidas	Food and beverage
16	Tabaco	Tobacco industries
17	Textiles	Textiles
18	Prendas de vestir y peletería	Wearing apparel and fur
19	Cuero y calzado	Leather and footwear
20	Madera y corcho (excepto muebles)	Wood and Cork (not formitures)
21	Cartón y papel	Pulp & paper
22	Edición, impresión y reproducción	Publ., print & repro. Of rec. Media

23	Coque, refinado de petróleo y combust.	Coke, ref petrol prod & nucl.fuel
24 (less 24.4)	Química (excepto farmacia)	Chemicals (less Pharmaceuticals)
24.4	Farmacia	Pharmaceuticals
25	Caucho y plástico	Rubber and Plastic
26	Minerales no metálicos	Non-metallic mineral product
27 (less 27.4)	Metales férreos	Ferrous metals
27.4	Metales no férreos	Non-ferrous metals
28	Manufacturas metálicas	Fabricated metal products
29	Maquinaria (n.c.o.p.)	Machinery n.e.c
30	Máquinas de oficina, cálculo y ordenadores	Office machinery & computers
31	Máquinas eléctricas	Electrical Machinery
32.1	Componentes electrónicos	Electronic components
32.2, 32.3	Aparatos de radio, tv y comunicación	Radio, TV and Communication equipment
33	Instrumentos óptica y relojería	Instruments
34	Automóviles	Motor vehicles
35.1	Naval	Ships construction
35.3	Aeroespacial	Aerospace
35.2, 35.4, 35. 5	Otro material de transporte	Other transport equipment
36.1	Muebles	Furniture
36 (less 36.1)	Otras manufacturas	Other manufacturing industries
37	Reciclaje	Recycling
40	Electricidad, gas y agua	Electricity, gas and water supply

Note and outline of the Spanish report for the focus group on Inter-Firm Collaboration of the OECD project on National Innovation Systems (phase 2). First draft, November 15, 1997.

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