

Analyses and evaluations of the academic activities in Humanities and Social Sciences in Taiwan

Presenter : Chia-Hao Hsu

Science & Technology Policy Research and Information
Center, NARL, Taiwan

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Outline

- **Background & Scope**
- Methodology
- **Result**
 - Academic research capital investment
 - **Human capital in academic research**
 - Overall performance in academic research
 - Type of knowledge integration in academic field
 - Type of research output
- Conclusion



Research background

- 12% of public R&D performed by Higher Education sector. National Science Council (NSC) is the main funding body
- Nearly 70% of Ph.D. level research fellow centralized in H.E. sector
- Higher education is the main source of nurturing human capital. Both the research and education functions are critical to National human capital's accumulation and creation. Higher education and academic research are the two sides of a unity
- Funding policy of NSC should effectively stimulate the promotions of human capital nurturing and academic performance
- The Taiwan's government set the research talent nurturing and academic competence promoting as the national development goal
- Tracing academic resource allocation and analyzing knowledge producing system and capacities are important

Research scope

- **Research projects**
 - 179,293 projects funded by NSC from 1991-2005
- **Research fellows**
 - 23,791 research fellows including professors from universities participating in NSC funded programs and projects
- **Analysis foci**
 - Funding allocation
 - **Human capital statistics**
 - Academic performance

Methodology (I)

- **Academic research capital investment**
 - Cross analyses of 5 different academic departments under NSC, different academic areas (disciplines), and grants. Display different resource allocations through time line
- **Human capital in academic research**
 - Using basic quality and professional competence to be two dimensions to confer the structures of researchers
 - Basic quality refers to age, gender, current position and institution, and academic background to be the main indicators.
 - Professional competence takes seniority, working experience, project experience, collaboration extent, to be the indicators
 - Analyzing interaction of different time line, years in projects and age to see if they could bring effect researchers' qualities.

Methodology (II)

- Overall performance in academic research
 - Type of knowledge integration
 - Using network analysis and statistics software to analyze the integration degree of knowledge domain and clusters. To explore key researchers and their research network.
 - Basing on researcher's domain academic area
 - Using frequency of project collaboration, project correlation and so forth to be the indicators for knowledge integration and clustering.
 - Using degree of network extension and connectivity to estimate researchers' activities and importance, as well as the research community.
 - Type of research output
 - Using Thomason-ISI to be the basic bibliometrics database for paper number and citation counts.

Methodology (III)

- **Classification of academic fields**
 - Basing on each researcher's professional specialty, his/her current department to replace NSC's previous hierarchical classification.
 - For the classification of academic fields, basing on Minister of Education's university department codes, we distinguish 20 main academic areas and divided them into 128 sub-fields
 - Besides, NSC's 5 academic departments are also the dimensions for analyzing.

Methodology (IV)

- **Researcher's active and important indexes**
 - Frequency: Neighbors of unit X (numbers of collaboration researchers)
 - Degree: $CD(X)$ = Links of unit X (collaboration numbers)
 - Connectivity index: Betweenness Centrality
 - Extension index: Closeness Centrality

	Researchers			
Basic indicators	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
(Active & Important)	□	□	□	□
(Active)	□	□		
(Active & Strong Partnership)		□		
(Important)			□	□

Result

I. Academic research capital investment

Observation base

- **Scale of capital investment**
 - Change of capital investment and growth rate
- **Centralization of resources**
 - **Distribution of funds in NSC academic departments**
 - Distribution of funds in academic fields
 - **Average grants for researchers**

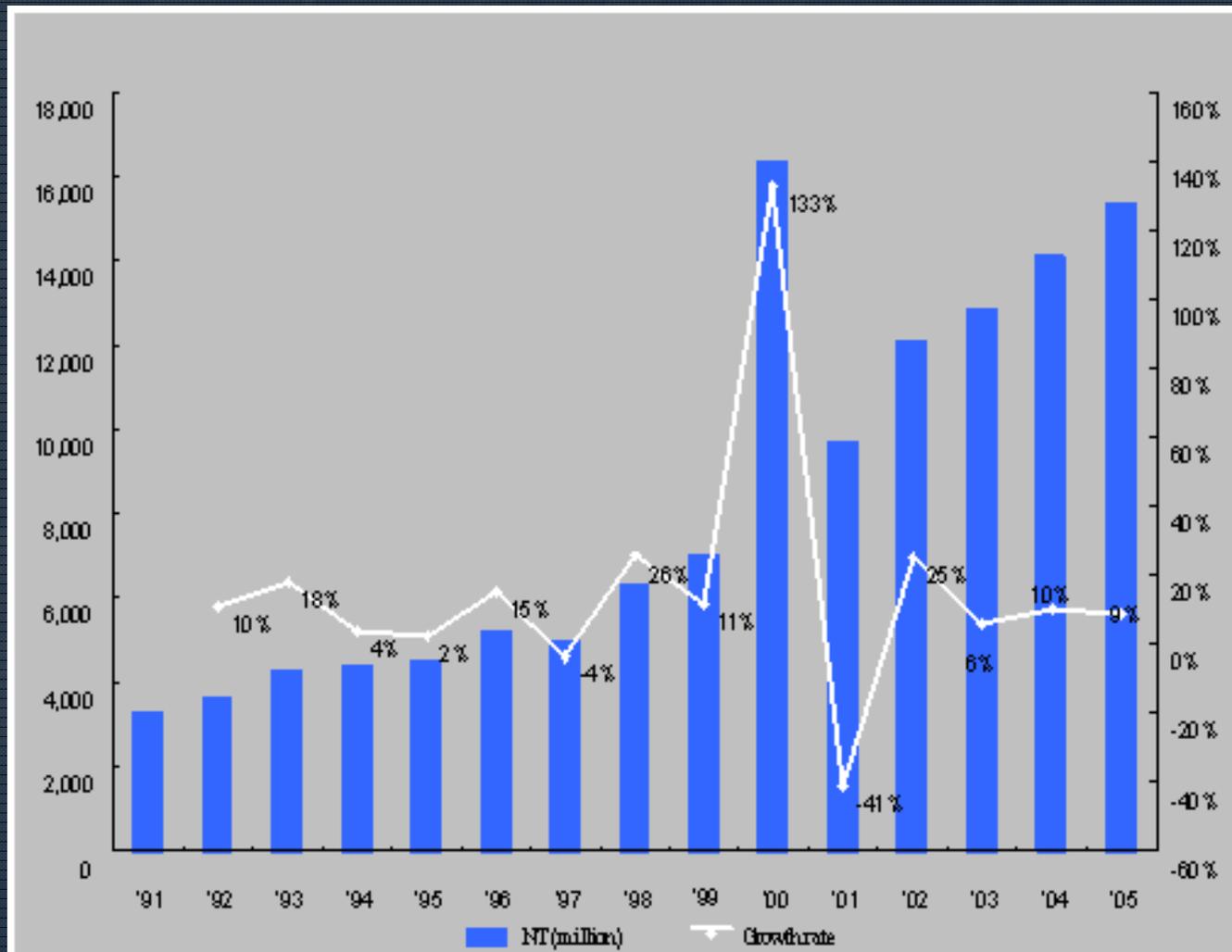
I. Academic research capital investment

- During 1991 to 2005, research R&D investment had a steady growth rate as 10+5%. However, that of each academic departments of NSC did not consist with each other.
- During 90s, the average research grant of each research decreased from NTD 1.02 million but increased after 2001. In 2005, the average research grants for each researcher reached to NTD 1.32 million, whereas the average amount for funding projects reached NTD 0.89 million.
- The structure of resource allocation in 5 academic departments of NCS remained the same in these 15 years, except an increasing one of the Department of Engineering and Applied Science (Dept. of EA).
- NSC invested mainly of its fund (88.3%) in seven major fields: engineering, natural science, medical science, math & computing, Agriculture, forestry, fishery & livestock industry, management, and sociology & psychology whereas 77.6% of the scholars (18,461/23,791) were supported.

I. Academic research capital investment

- For the average accumulated grants of each researcher during 1991 to 2005, the medical science had the highest one, which was NTD 9.7 millions. Natural science and engineering came after as NTD 7.6 millions and NTD 6.7 millions.
- Researchers in medical science consisted in 10% of the total researchers. However, the average grant for each researcher in this field was three times as that of researchers in other fields.

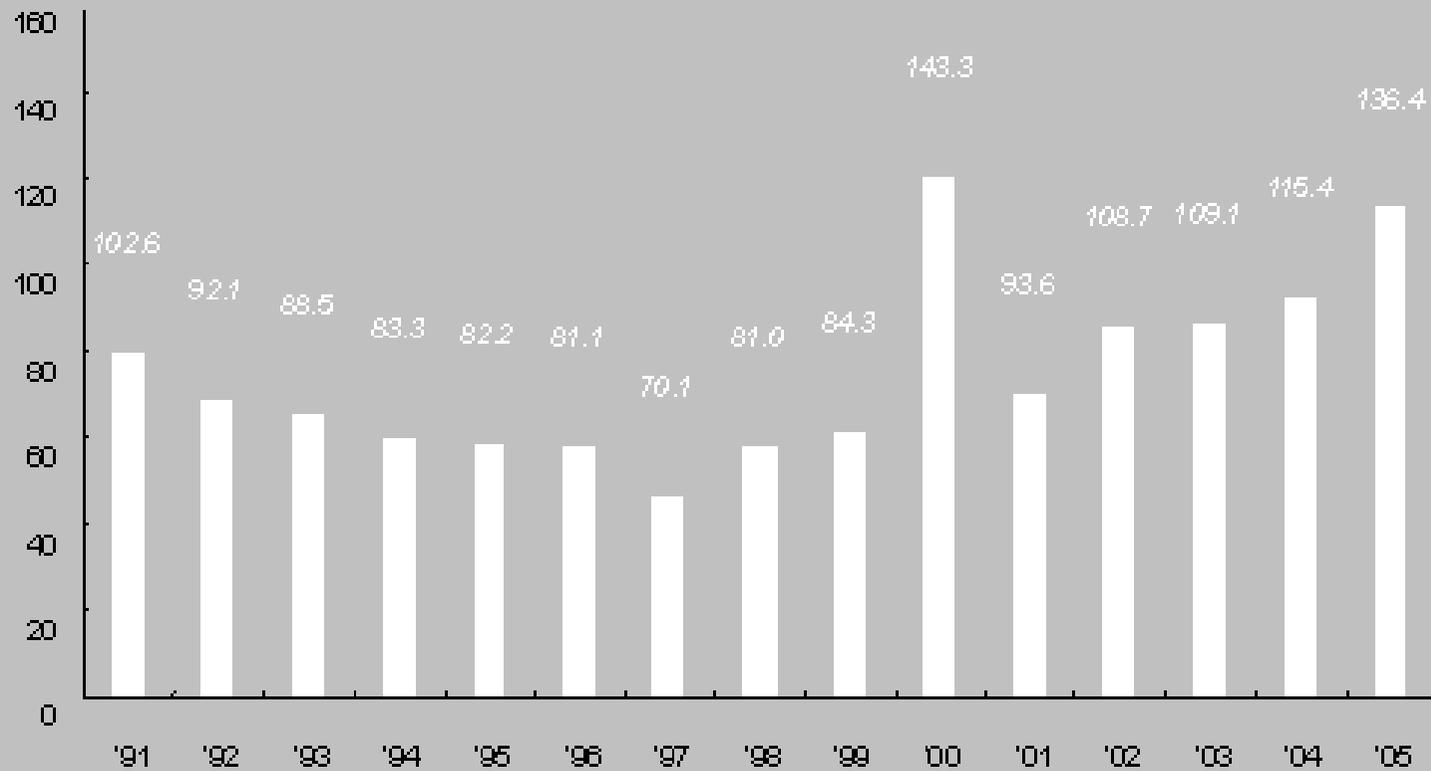
Growth trend of NSC commissioned fund by year



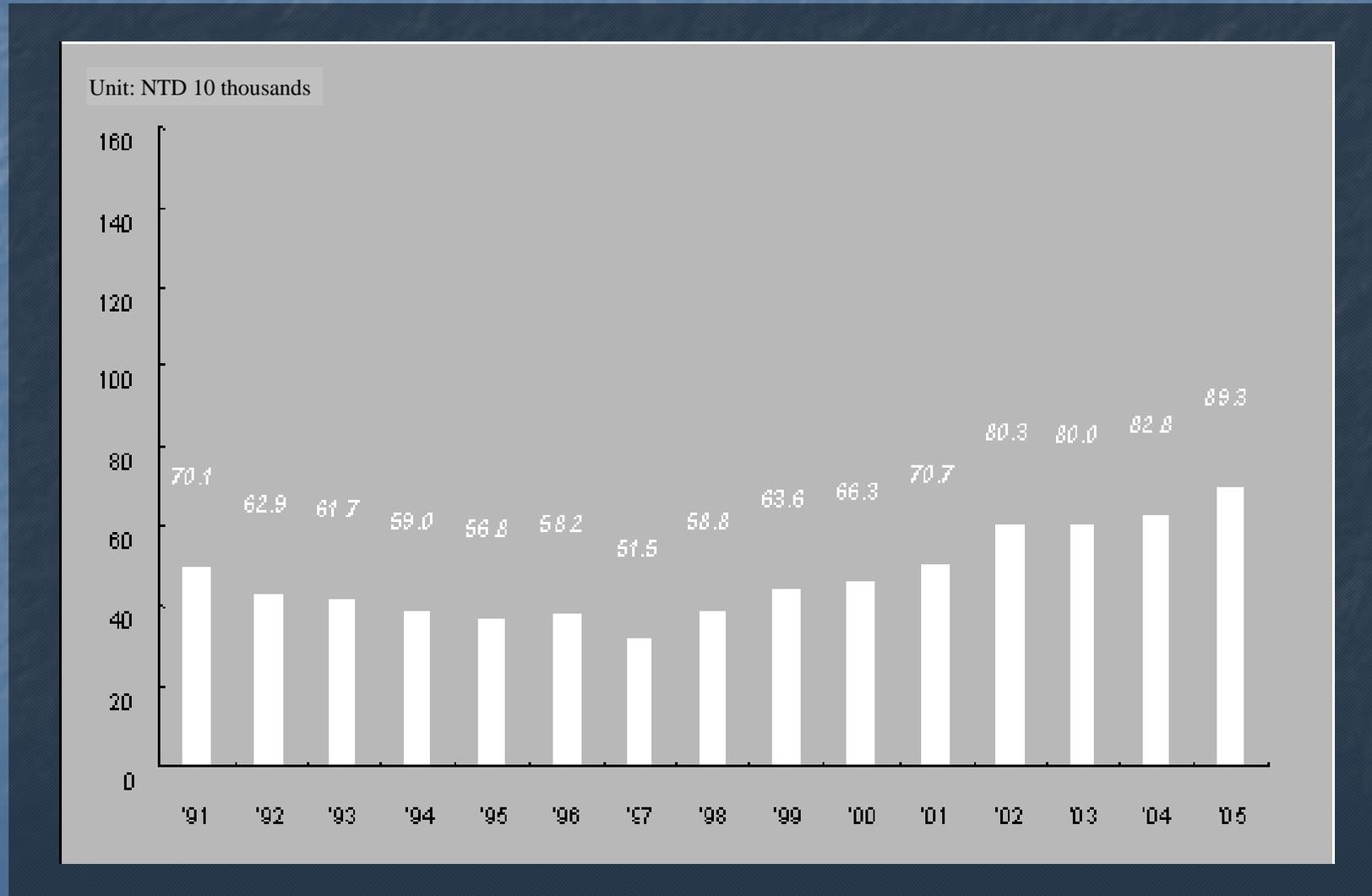
Yr 2000 was counted for 1.5 fiscal year

Average research fund per capita by year

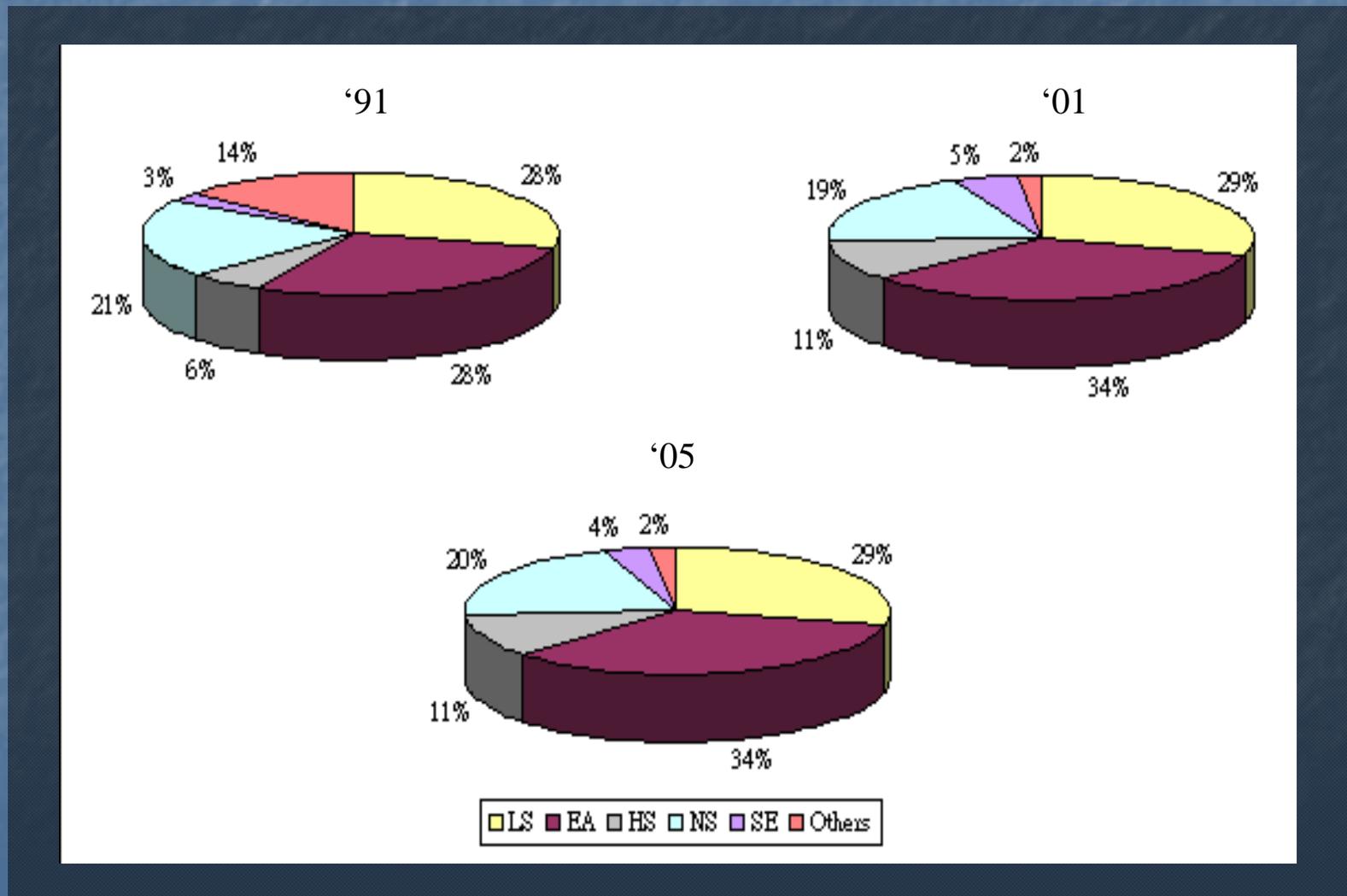
Unit: NTD 10 thousands



Average project fund received per capita by year



Funding allocation for each dept. in NSC (‘91/’01/’05)



Funding and researchers' population by fields ('91-'05)

20 research fields	total investment	% of investment	No. of scholars	% of scholars	Ave. funding per capita
<i>Engineering</i>	37250	30.05%	5557	24.60%	6.7
<i>Natural science</i>	27037	21.81%	3578	15.80%	7.6
<i>Medical science</i>	21645	17.48%	2254	10.00%	9.6
<i>Math & Computing</i>	8201	6.61%	1900	8.40%	4.3
<i>Agri, forestry, fishery & livestock ind.</i>	5952	4.80%	1792	7.90%	3.3
<i>Management</i>	5376	4.34%	1380	6.10%	3.9
<i>Social & psychology</i>	4005	3.23%	1095	4.80%	3.7
<i>Others</i>	3733	3.01%	1065	4.70%	3.5
<i>Education</i>	3001	2.42%	1032	4.60%	0.9
<i>Humanities</i>	2378	1.92%	915	4.00%	2.6
<i>Architecture & City planning</i>	982	0.79%	401	1.80%	2.4
<i>General knowledge</i>	905	0.73%	325	1.40%	2.8
<i>Housecraft</i>	747	0.60%	283	1.30%	2.6
<i>Transportation & Telecommunication</i>	613	0.49%	205	0.90%	3
<i>Sports</i>	540	0.44%	193	0.90%	2.8
<i>Law</i>	520	0.42%	187	0.80%	2.8
<i>Arts</i>	446	0.36%	185	0.80%	2.4
<i>Mass communication</i>	443	0.36%	173	0.80%	2.6
<i>Tourism</i>	130	0.11%	61	0.30%	2.1
<i>Craft technology</i>	46	0.04%	13	0.10%	3.5

Unit: million (NTD)

Funding and researchers' allocation for each dept. (’91-’05)

20 Research fields	Dept. of LS		Dept. of ES		Dept. of HS		Dept. of NS		Dept. of SE	
	\$ Mount (million)	No. of Researchers								
<i>sociology & psychology</i>	172.36	22	212.98	48	3149.71	1462	172.02	49	186.98	88
<i>Management</i>	573.71	106	810.87	621	2959.73	2210	779.75	320	170.6	115
<i>Humanities</i>	11.97	13	74.53	26	2189.11	1568	5.58	7	72.1	57
<i>Education</i>	92.71	48	129.1	97	1230.04	965	78.52	75	1456.73	586
<i>Math & Computing</i>	167.02	63	4623.3	1973	677.34	532	1967.93	733	581.68	304
<i>Law</i>	40.3	7	26.28	13	439.07	329	1.91	1	2.22	3
<i>Medical science</i>	18711.65	4683	1240.96	538	397.93	277	711.23	201	281.32	166
<i>Mass communication</i>	5.82	7	47.52	46	345.62	227	2.17	4	29.43	26
<i>General knowledge</i>	137.11	78	124.81	77	332.86	388	136.37	100	157.29	137
<i>Engineering</i>	993.61	385	30777.89	9082	324.14	240	2844.29	519	693.84	548
<i>Sports</i>	42.72	36	61.65	52	322.49	274	87	50	13.99	20
<i>Others</i>	1750.78	747	804.71	309	251.99	223	629.91	186	170.38	141
<i>Arts</i>	24.27	14	90.77	67	243.91	196	27.33	8	22.52	27
<i>Architecture & City planning</i>	22.53	15	697.42	367	225.67	149	0.48	1	17.82	25
<i>Agriculture, forestry, fishery & livestock ind.</i>	5125.43	1144	351.8	199	163.13	77	231.61	52	64.32	27
<i>Transportation & Telecommunication</i>	0.9	1	462.77	235	125.15	94	5.96	5	8.66	10
<i>Housecraft</i>	488.24	200	79.17	56	95.33	101	47.38	29	32.01	28
<i>Natural science</i>	7287.9	1306	1210.5	439	82.83	56	17451.67	1860	548.96	187
<i>Tourism</i>	32.73	23	11.51	19	65.44	76	0.32	1	19.77	18
<i>Craft technology</i>	0.54	1	39.91	38						
Total	35681.11	8932	41878.5	14302	13621.51	9444	25181.42	4201	4530.61	2513

Grant distributions of projects by attributes ('91-'05)

20 research area	General research project		Specialty research project		National Defense research program		National S&T research program		Industry promotion & humancapital nurturing program		Fresh researchers supported project	
	Total amount (million)	%	Total amount (million)	%	Total amount (million)	%	Total amount (million)	%	Total amount (million)	%	Total amount (million)	%
<i>Humanities</i>	19.10	2.10%	0.35	1.62%	0.04	0.31%	0.76	0.98%	0.02	0.17%	3.39	2.60%
<i>Mass communication</i>	2.94	0.32%			0.08	0.23%	0.49	0.63%	0.04	0.28%	0.85	0.65%
<i>Engineering</i>	263.81	29.04%	5.68	26.61%	7.31	60.68%	21.56	27.74%	10.51	71.56%	33.05	25.32%
<i>Craft technology</i>	0.16	0.02%							0.04	0.28%	0.18	0.14%
<i>Natural science</i>	200.73	22.10%	6.56	32.18%	1.99	16.50%	19.36	24.91%	0.71	4.85%	23.20	17.77%
<i>Others</i>	32.98	3.63%	0.26	1.20%	0.30	2.51%	0.79	1.01%	0.05	0.34%	2.02	1.55%
<i>Law</i>	3.88	0.43%			0.01	0.05%	0.41	0.53%	0.08	0.19%	0.81	0.62%
<i>Architecture & City planning</i>	7.63	0.84%	0.12	0.58%	0.00	0.04%	0.38	0.49%	0.22	1.52%	1.34	1.02%
<i>Sports</i>	4.10	0.45%			0.06	0.53%	0.06	0.08%	0.07	0.46%	1.00	0.77%
<i>Housecraft</i>	4.98	0.55%	0.20	0.95%	0.02	0.13%	0.18	0.23%	0.12	0.83%	1.70	1.30%
<i>Management</i>	40.00	4.40%	0.36	1.67%	0.36	3.01%	0.38	0.49%	0.45	3.10%	10.41	7.98%
<i>Education</i>	22.81	2.51%	0.11	0.50%	0.00	0.04%	0.92	1.18%	0.05	0.37%	5.18	3.97%
<i>General knowledge</i>	5.56	0.61%			0.13	1.05%	0.28	0.36%	0.10	0.67%	2.58	1.98%
<i>sociology & psychology</i>	30.81	3.39%	0.64	3.02%	0.12	0.98%	0.75	0.97%	0.04	326.00%	5.82	4.46%
<i>Agri, forestry, fishery & livestock ind.</i>	44.06	4.85%	1.93	9.03%	0.08	0.26%	6.34	8.16%	0.31	2.13%	5.18	3.97%
<i>Transportation & Telecommunication</i>	4.50	0.49%			0.09	0.73%	0.30	0.39%	0.08	0.51%	1.02	0.78%
<i>Math & Computing</i>	55.59	6.12%	1.29	6.05%	1.31	10.89%	5.46	7.08%	1.08	7.36%	10.13	7.76%
<i>Medical science</i>	160.86	17.71%	3.54	16.52%	0.24	2.02%	18.82	24.21%	0.66	4.46%	21.63	16.57%
<i>Arts</i>	3.05	0.34%			0.00	0.04%	0.48	0.61%	0.07	0.45%	0.51	0.39%
<i>Tourism</i>	0.73	0.08%							0.02	0.14%	0.53	0.41%
<i>Total</i>	908.27		21.33		12.05		77.73		14.69		130.53	

Accumulated average grants per researcher by project type ('91-'05)

20 research area	General research project		Specialty research project		National Defense research program		National S&T research program		Industry promotion & humancapital nurturing program		Fresh researchers supported project	
	No. of applied researchers	Ave. grants (million)	No. of applied researchers	Ave. grants (million)	No. of applied researchers	Ave. grants (million)	No. of applied researchers	Ave. grants (million)	No. of applied researchers	Ave. grants (million)	No. of applied researchers	Ave. grants (million)
<i>Engineering</i>	5557	4.75	95	5.97	502	1.46	314	6.87	1467	0.72	2808	1.18
<i>Medical science</i>	3578	4.50	47	7.53	21	1.16	253	7.44	118	0.56	1672	1.32
<i>Natural science</i>	2254	8.91	66	10.40	73	2.72	235	8.24	106	0.67	945	2.45
<i>Math & Computing</i>	1900	2.93	23	5.61	101	1.30	159	3.44	187	0.58	1149	0.88
<i>Management</i>	1792	2.23	7	5.10	33	1.10	19	2.02	99	0.46	1345	0.77
<i>Others</i>	1380	2.39	6	4.25	21	1.44	24	3.29	10	0.50	214	0.94
<i>Humanities</i>	1095	1.74	9	3.85	2	1.86	26	2.93	3	0.81	524	0.65
<i>sociology & psychology</i>	1065	2.89	15	4.30	10	1.18	30	2.51	7	0.54	563	1.04
<i>Education</i>	1032	2.21	2	5.35	1	0.45	45	2.04	10	0.54	581	0.89
<i>Agriculture, forestry, fishery & livestock ind.</i>	915	4.82	25	7.70	3	1.05	113	5.61	53	0.59	332	1.56
<i>General knowledge</i>	401	1.39			5	2.53	15	1.87	16	0.61	323	0.80
<i>Architecture & City planning</i>	325	2.35	1	12.43	1	0.46	20	1.89	50	0.45	152	0.88
<i>Sports</i>	283	1.45			6	1.06	8	0.79	8	0.85	133	0.46
<i>Law</i>	205	1.89			1	0.61	17	2.43	4	0.72	122	0.66
<i>Arts</i>	193	1.58			1	0.47	20	2.39	13	0.51	82	0.62
<i>Transportation & Telecommunication</i>	187	2.40	3	6.78	9	0.98	7	4.35	18	0.46	118	0.86
<i>Housecraft</i>	185	2.69			1	1.56	8	2.25	26	0.47	157	1.08
<i>Mass communication</i>	173	1.70			1	2.83	16	3.06	7	0.58	114	0.74
<i>Tourism</i>	61	1.19							7	0.30	63	0.84
<i>Craft technology</i>	13	1.25							8	0.52	14	1.31

Top 15 allocations of research funds in sub-fields (’91-’05)

Top 15 sub-fields	Total amount (million)	%
Meicine	138.6	11.50%
Electron & electric machinery	129.3	10.70%
Biology	73.7	6.10%
Physics	71.86	5.90%
Mechanical engineering	71.37	5.90%
Chemistry	69.59	5.80%
Computer science	60.9	5.00%
Chemical engineering	37.4	3.10%
Others	36.07	3.00%
Material engineering	33.93	2.80%
Geology	26.48	2.20%
Business administration	23.43	1.90%
Multi-discipline in medical science	21.12	1.70%
Environment engineering	20.79	1.70%
Civil engineering	19.26	1.70%

II. Human capital in academic research

Observation base

- **Generation**
- Aging
- **Globalisation vs. Localization**
- Purebred Academia

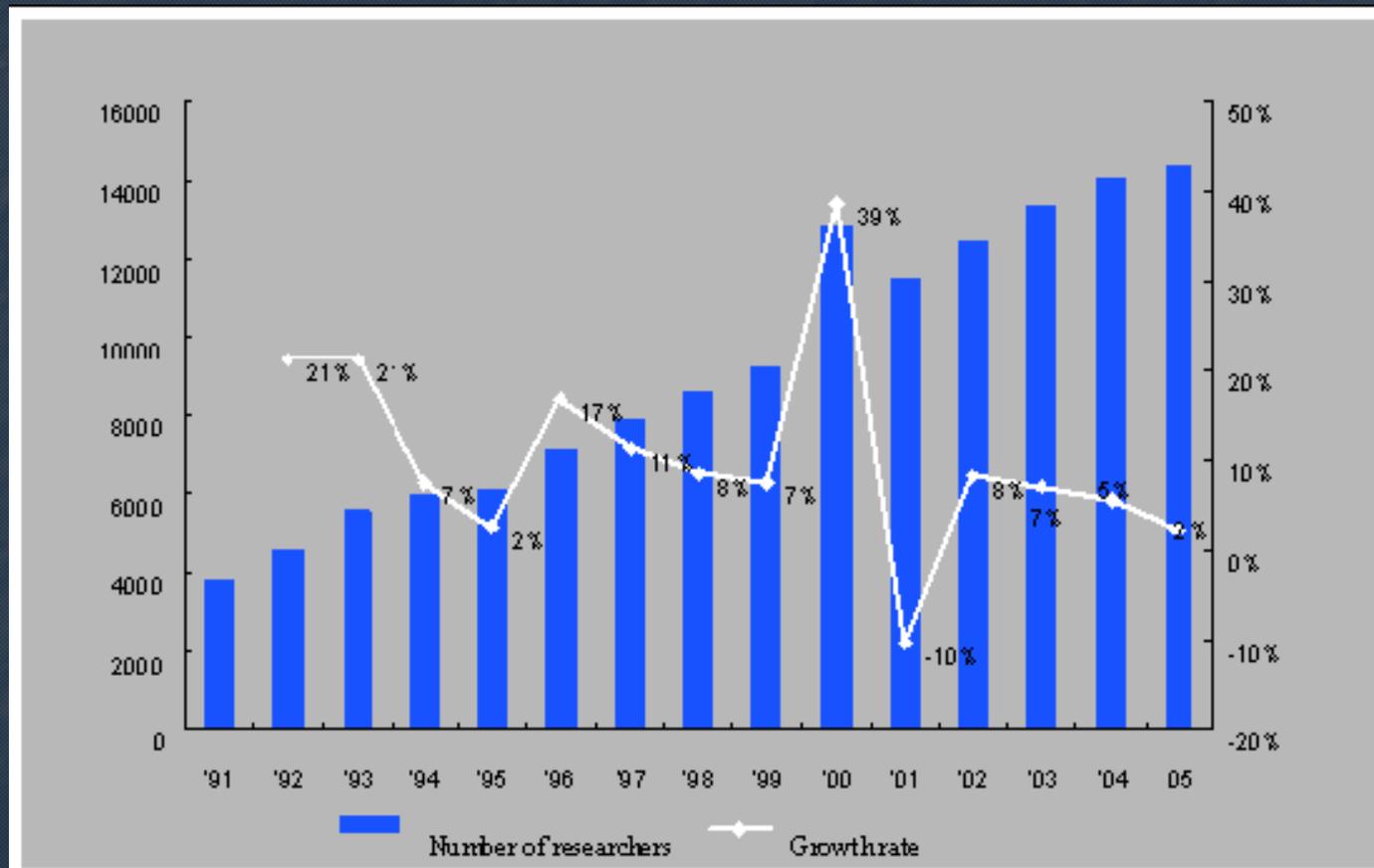
II. Human capital in academic research

- Research talents increased from 3,700 in 1991 to 14,000 in 2005. However, the growth rate decreased in recent years.
- Scholars were grouped into three categories:
 - Senior researchers with age over 56, who started his/her academic career in 60s to 70s;
 - Mature researchers with age between 41 to 55, who starts academic career in 80s; and
 - Novices with age under 40, who starts the career in late 90s.
- It is found that the distributions of three age categories were 19%, 64%, and 17% among the scholars. 25% of the scholars were in the age of 41-45 which represented the largest share.
- Accompanying with the increment R&D investment by the government, mature researchers could be granted for 0.66 million per project per person. They are the cores of Taiwanese research community nowadays.

II. Human capital in academic research

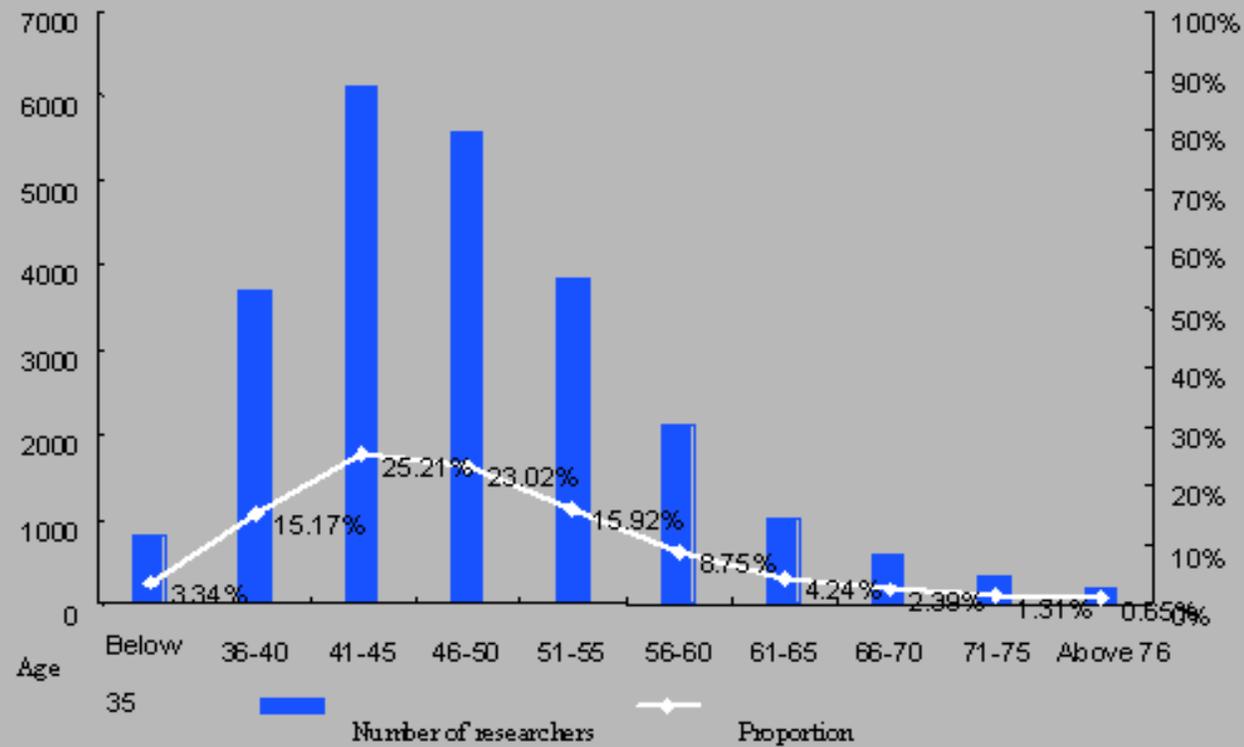
- Due to some policy effects, the proportions of professor, associate professor, and assistant professor changed from 1991 to 2005. The rates changed from 1991 as 29%, 71%, and 0%, to 54%, 29%, and 17% in 2005.
- 83.7% of the researchers possessed Ph.D degrees, 41% of which were domestic ones.
- 77.6% of the scholars belonged to the main 7 academic fields.
- More than 50% of the researchers possessed working experience in 10+ years. However, 64% of the researchers had pure academic experiences.
- In mature researcher group, 85% of the researchers are able to receive NSC projects in 5 years after completing their previous NSC granted ones.
- Analysis also shows that only 14% of all the researchers received their NSC granted projects the first time.

Number of research talents and growth rate by year

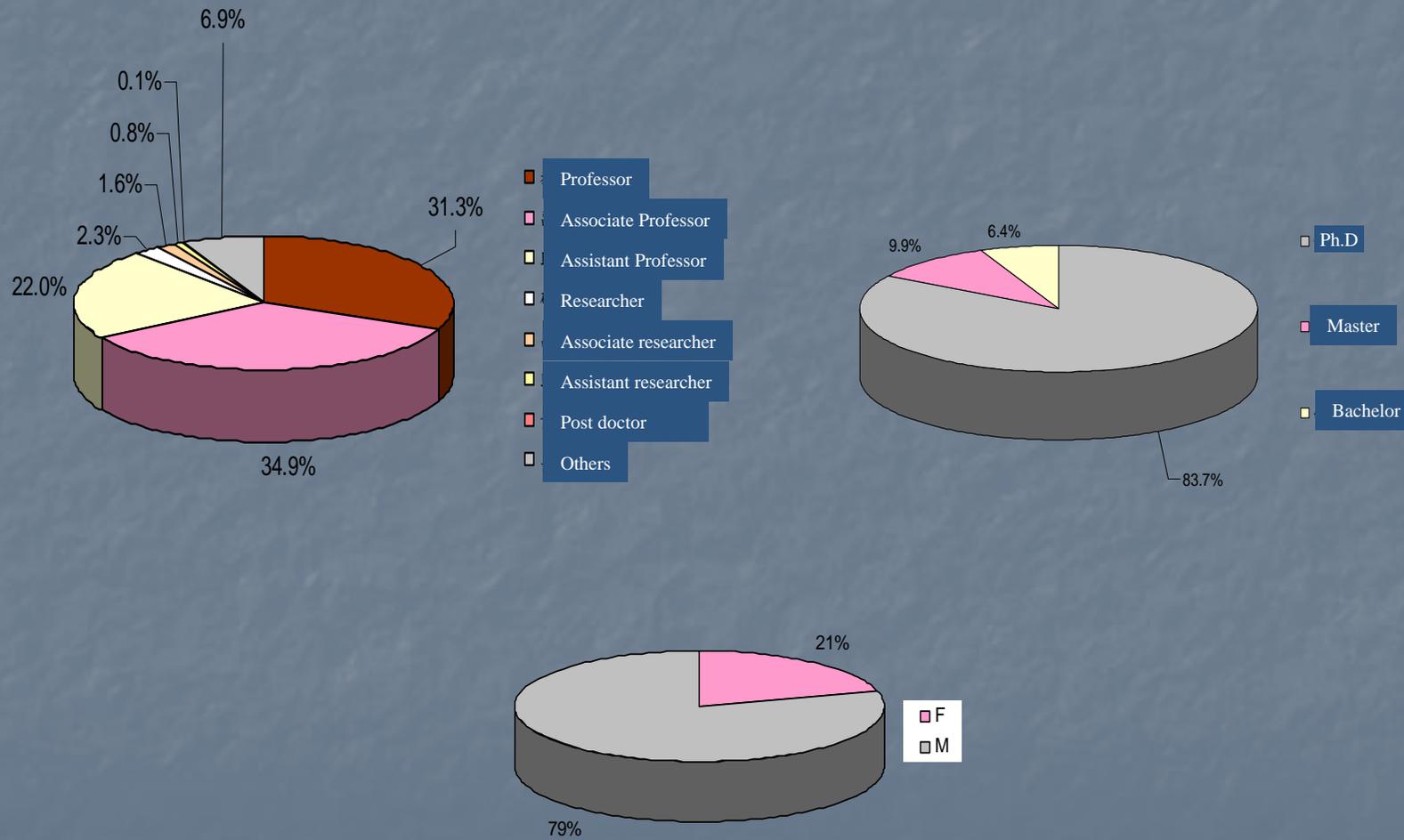


Yr 2000 was counted for 1.5 fiscal year

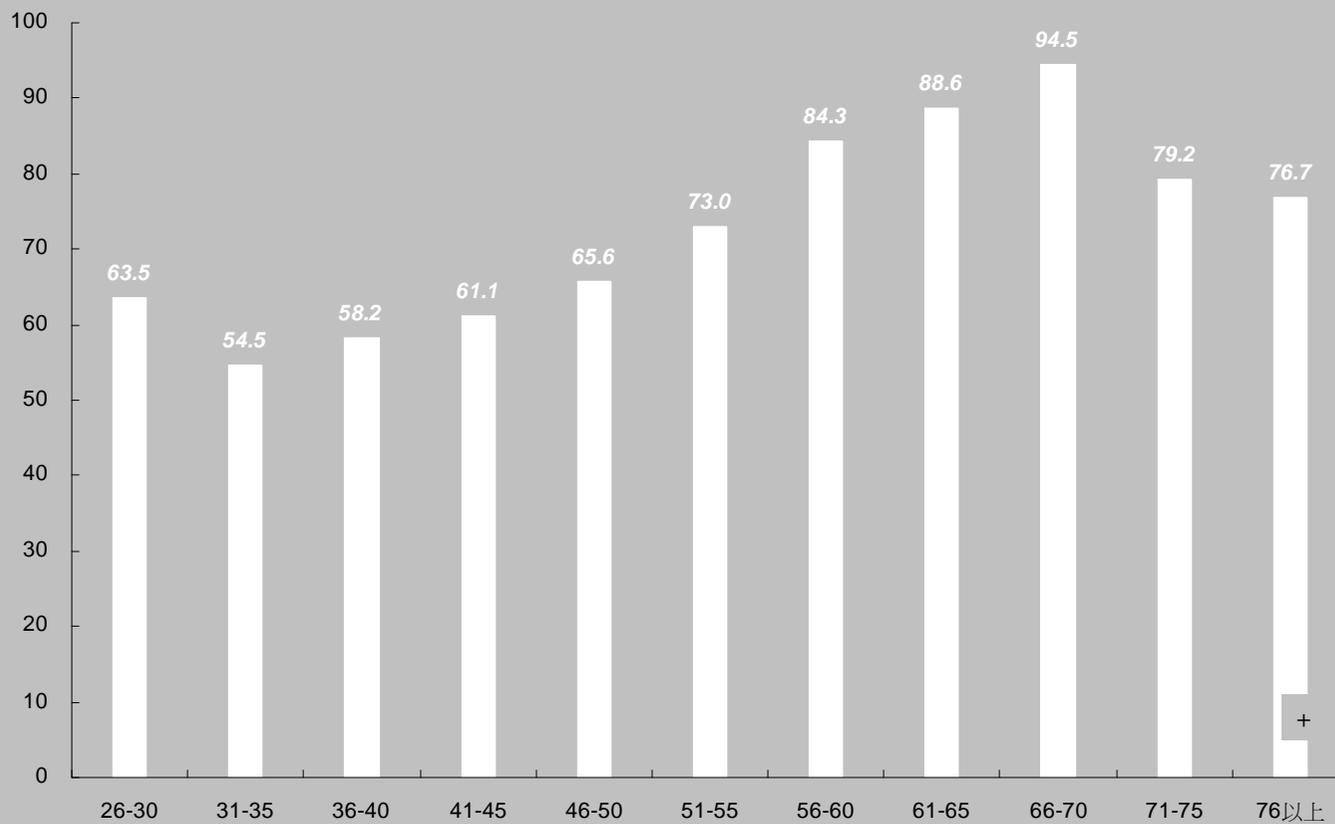
Age distribution of total research talents ('91-'05)



Some attributes of research talents



Average research grants (by age groups)

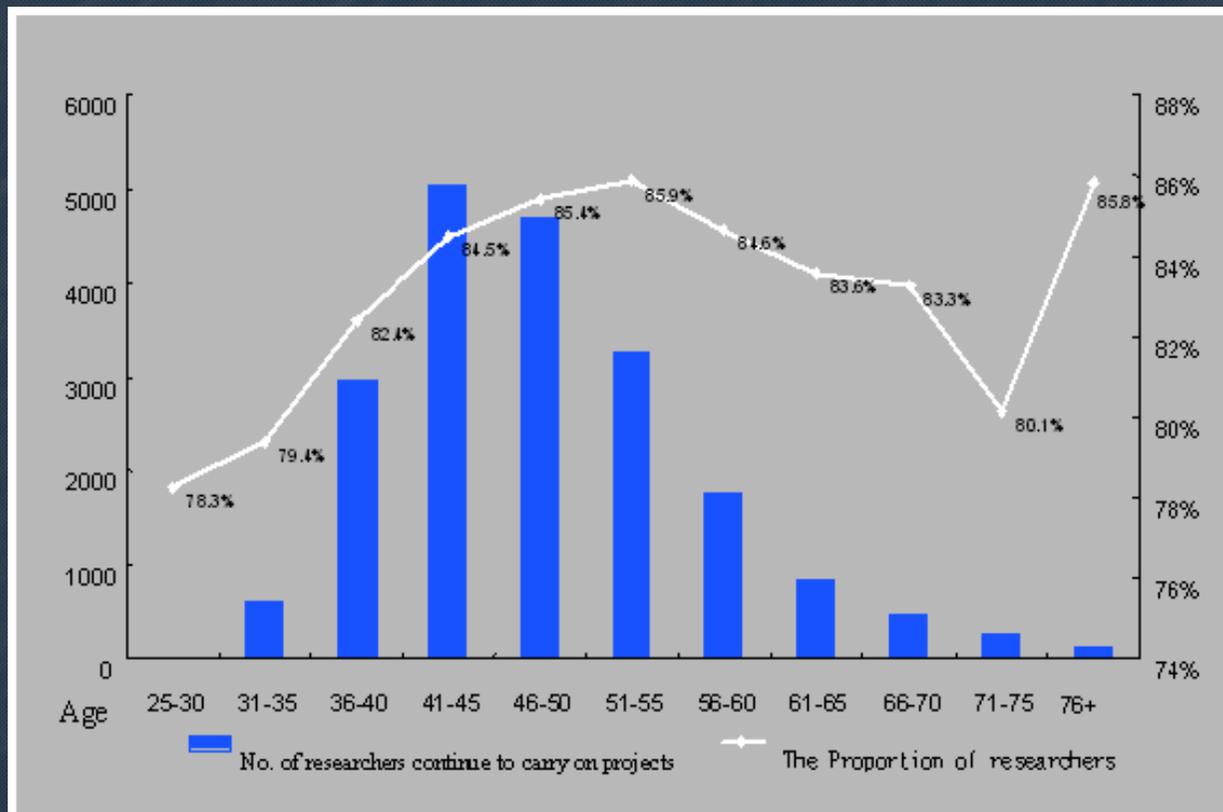


Unit: NTD 10 thousands

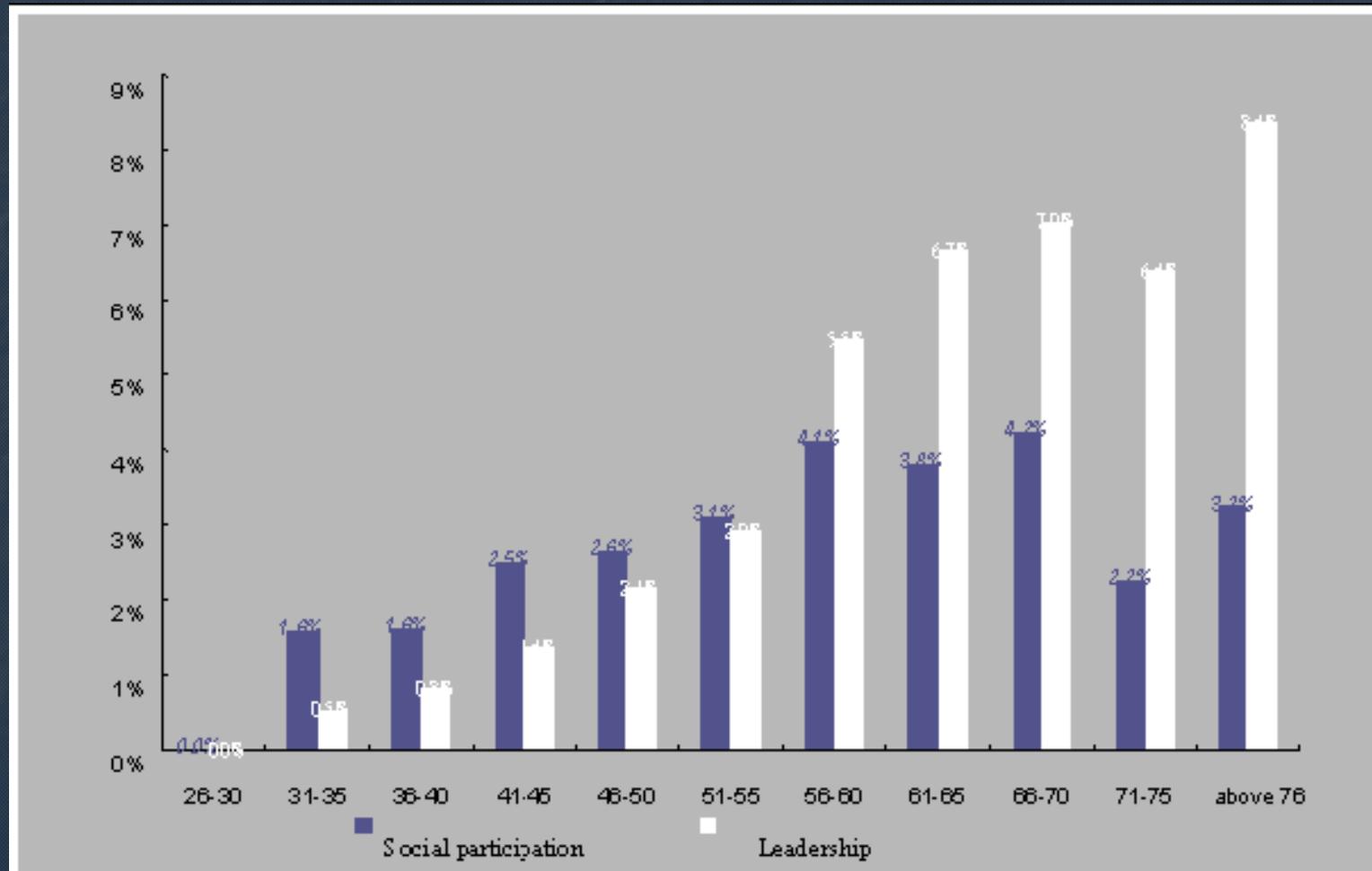
Proportions of different working experience in each age group

Age group	Number of researchers with industrial experience	% (of total 20128)	Number of researchers with only academic experience	% (of total 20128)
26-30	3	0.01%	9	0.04%
31-35	83	0.41%	382	1.90%
36-40	591	2.94%	1978	9.83%
41-45	1169	5.81%	3239	16.09%
46-50	1061	5.27%	2992	14.86%
51-55	758	3.77%	2064	10.25%
56-60	430	2.14%	1094	5.44%
61-65	187	0.93%	551	2.74%
66-70	116	0.58%	297	1.48%
71-75	59	0.29%	175	0.87%
above 76	23	0.11%	86	0.43%
Total	4480	22.26%	12867	63.93%

Number and proportion of researchers to receive NSC projects again in 5 years after completing previous ones



Proportions of researchers in social participation and leadership by age groups



III. Overall performance in academic research

Observation base

- Type of knowledge integration in academic field
 - Project collaboration
 - Correlation of multi-discipline integration
 - Important knowledge integration network

III. Overall performance in academic research

- It was observed that 60% of the scholars were once Principle Investigators (PI) or had participated in joint programs
- There is an increasing trend for the average of collaboration partners.
- More than 40% of the scholars complete the projects through collaborations
- 4% of the researchers had participated in the projects which contained more than 2 academic areas.

Degree of research collaboration ('91-05)

Total persons of project collaboration	Number of scholars
none	9484
1 person	5640
2-5 persons	6881
6-10 persons	1343
11-20 persons	386
20-50 persons	57
	23791

Total person-times of project collaboration	Number of scholars
0	9484
1 person-time	3438
2-5 person-times	6281
6-10 person-times	2422
11-20 person-times	1453
21-50 person-times	642
51-100 person-times	68
101+ person times	3
	23791

Proportion of researchers to carry out cross discipline projects by years



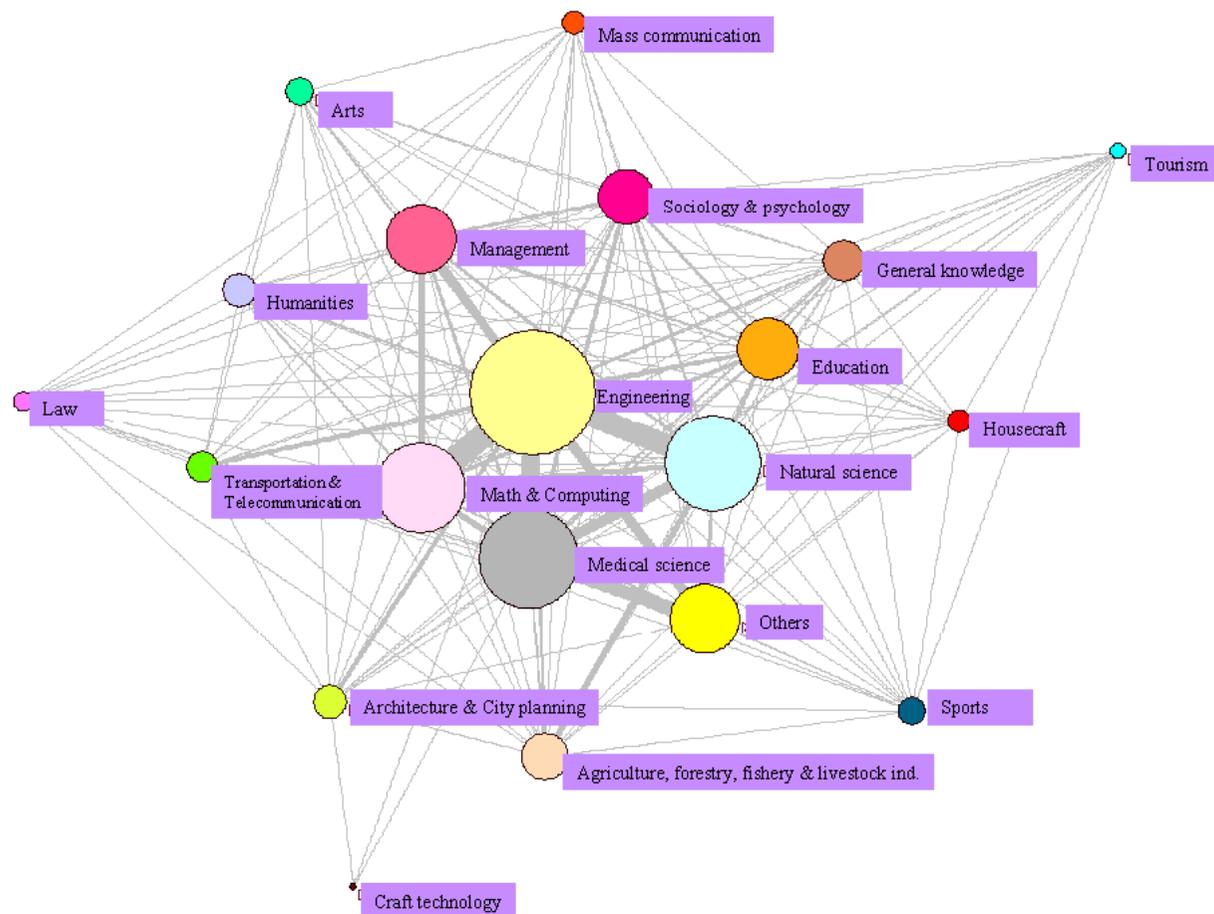
III. Overall performance in academic research

- From 1991 to 2005, more than 70% of researchers had less than 20 partners in their works. The highest person-time was 113.
- Among 20 main academic areas, more than 65% of researchers had participated in Engineering, medical science, natural science, and sports. Less than 35% had participated in Humanities and law.
- Although there are connections among different research areas, researchers in engineering area are the cores for others to contact
- The sketches of researchers' collaborations were quite complex and squeezed. They implied that the research topics were diverse and the special relations among Taiwanese research communities.

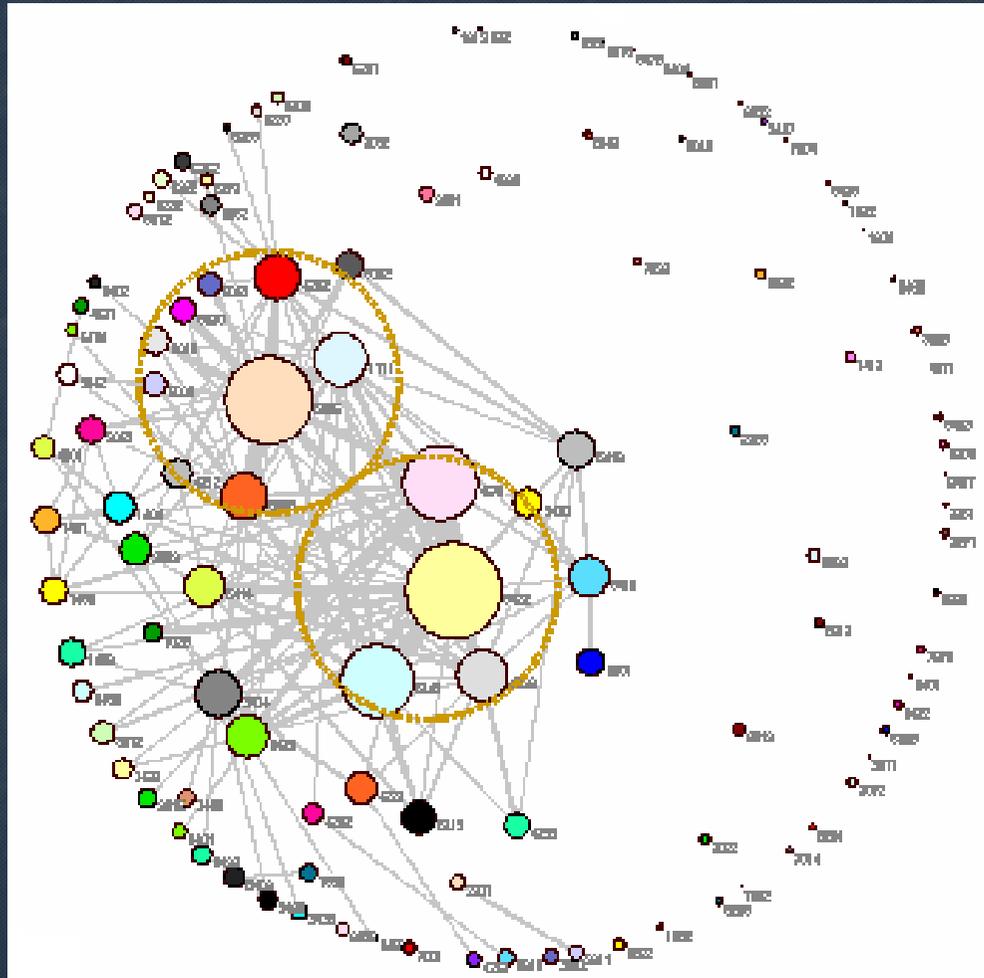
Degrees of collaboration in project by 20 research areas

20 research area	Total Number of researchers	Researchers with project collaboration	% of research collaboration
<i>Engineering</i>	5708	4067	71.25%
<i>Medical science</i>	3646	2565	70.35%
<i>Natural science</i>	2116	1403	66.30%
<i>Math & Computing</i>	1989	1215	61.09%
<i>Management</i>	2149	1123	52.26%
<i>Education</i>	1087	679	62.47%
<i>Others</i>	1373	609	44.36%
<i>sociology & psychology</i>	1188	576	48.48%
<i>Agriculture, forestry, fishery & livestock ind.</i>	907	471	51.93%
<i>General knowledge</i>	547	260	47.53%
<i>Architecture & City planning</i>	331	214	64.65%
<i>Humanities</i>	1286	345	26.83%
<i>Sports</i>	285	200	70.18%
<i>Transportation & Telecommunication</i>	188	111	59.04%
<i>Arts</i>	207	98	47.34%
<i>Housecraft</i>	226	137	60.62%
<i>Mass communication</i>	210	107	50.95%
<i>Law</i>	235	72	30.64%
<i>Tourism</i>	92	43	46.74%
<i>Craft technology</i>	21	12	57.14%

Collaboration network of 20 main research areas



Integration network of 128 sub-fields (only shows the sub-fields in which the collaboration researcher number is greater than 30)



Core scholars of knowledge network

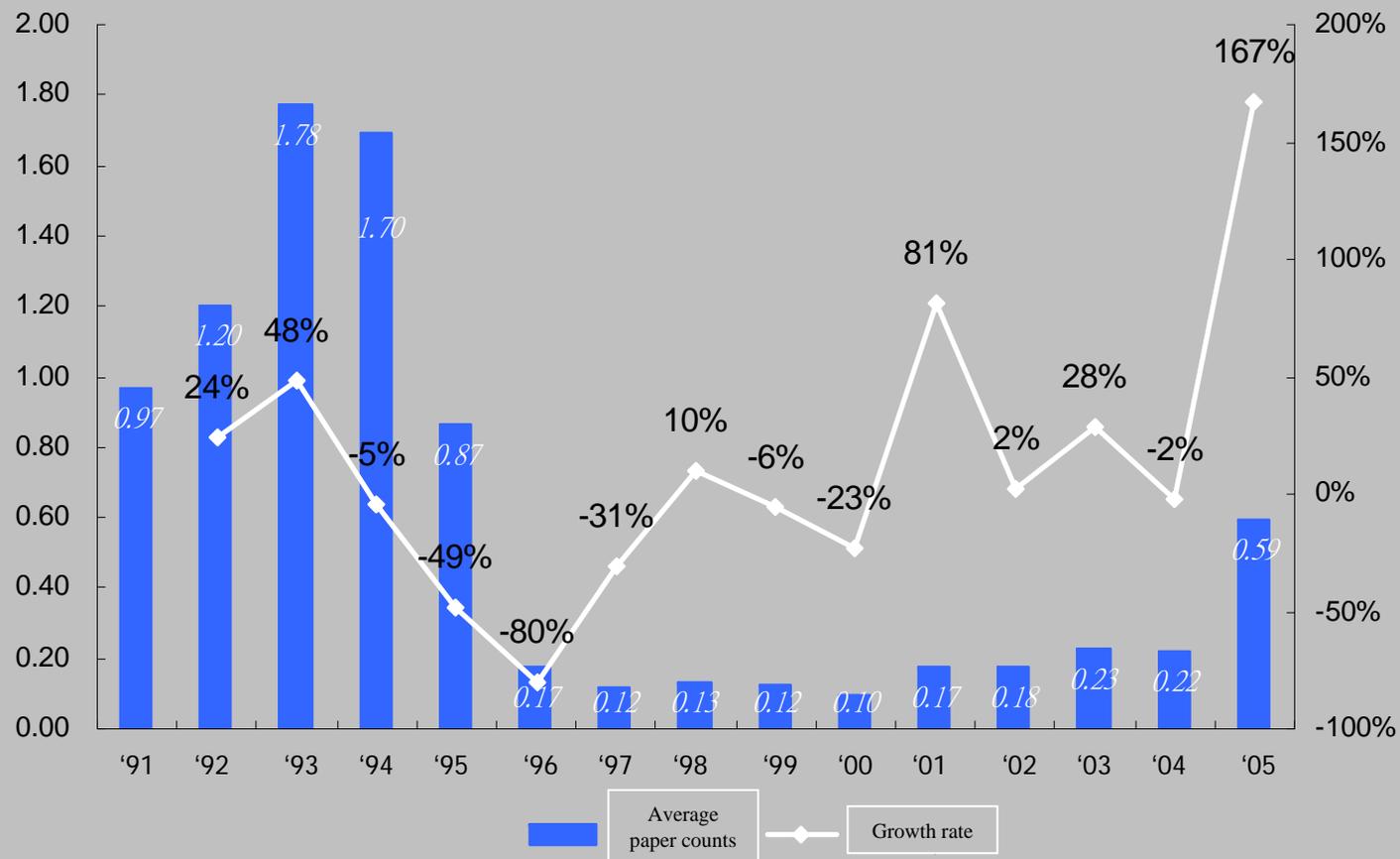
Type	Name	Affiliation	Position	age	Collaboration (Frequency)		Times (Degree)		Extension (Closeness Centrality)		Connectivity (Betweenness Centrality)	
					Value	Rank	Value	Rank	Value	Rank	Value	Rank
(Active & Important)	A	Aaa	Prof.	69	50	1	103	3	0.0927	1	0.0133	1
	B	Bbb	Prof.	47	33	4	91	6	0.0902	5	0.0077	2
	C	Ccc	特聘教授	48	39	2	127	2	0.0891	9	0.0055	9
	D	Ddd	Prof.	52	29	10	83	12	0.0891	10	0.0051	14
(Active)	E	Eee	Prof.	65	33	6	132	1	NA	>400	0.0032	36
	F	Fff	Prof.	57	36	3	71	21	NA	>400	0.0051	11
	G	Ggg	Prof.	47	29	9	87	8	0.0872	29	0.0034	32
	H	Hhh	Director	63	33	5	68	27	0.0853	55	0.0056	7
(Active & Strong Partnership)	I	lii	Prof.	63	20	58	92	4	0.0894	95	0.0030	40
	J	Jjj	Associate prof.	52	22	35	92	5	NA	>400	0.0026	55
	K	Kkk	Prof.	52	NA	>400	86	10	0.0827	163	0.0020	104
	L	Lll	Prof.	50	24	27	86	9	0.0893	8	0.0050	15
(Important)	M	Mmm	Prof.	58	27	16	58	46	0.0908	2	0.0064	3
	N	Nnn	Prof.	48	23	30	76	17	0.0903	40	0.0057	6
	O	Ooo	Prof.	63	26	18	89	7	0.0879	21	0.0060	4
	P	Ppp	Prof.	63	28	14	NA	>400	0.0895	6	0.0056	8

III. Overall performance in academic research

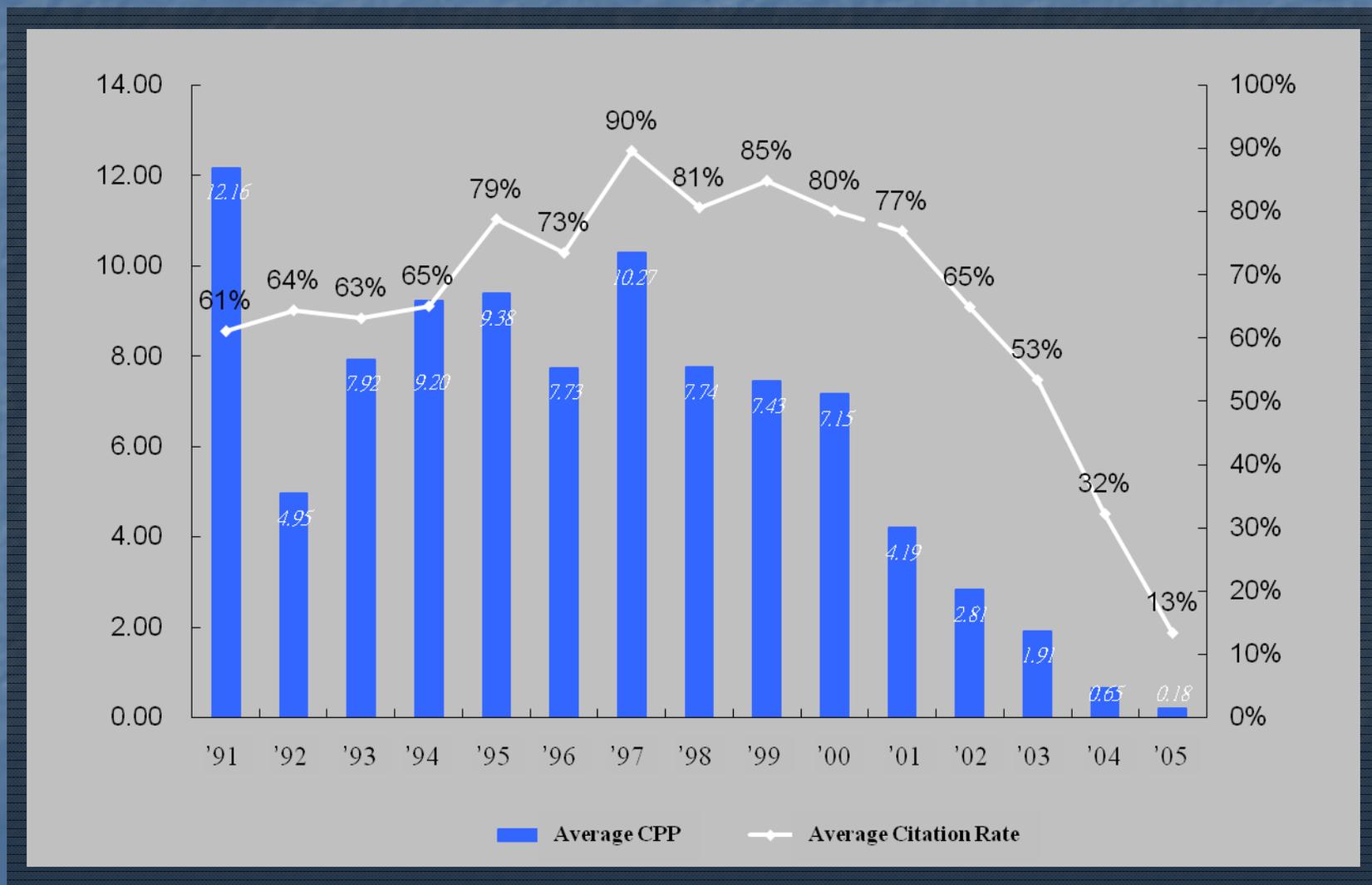
Observation base

- **Type of research output**
 - Average paper counts and growth rate
 - Citation per paper
 - Average citation per paper

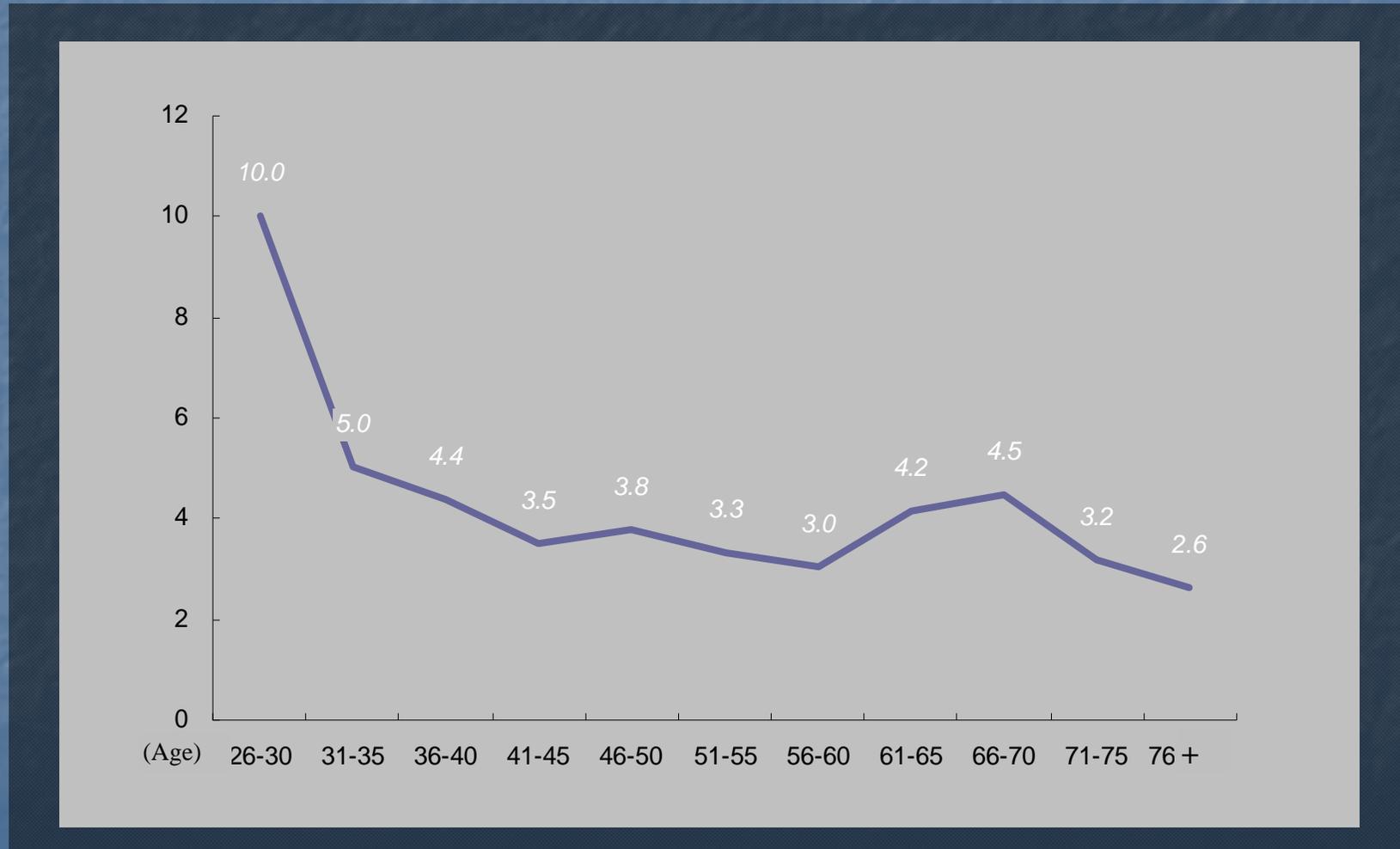
Average paper counts and growth rate in SSCI by year



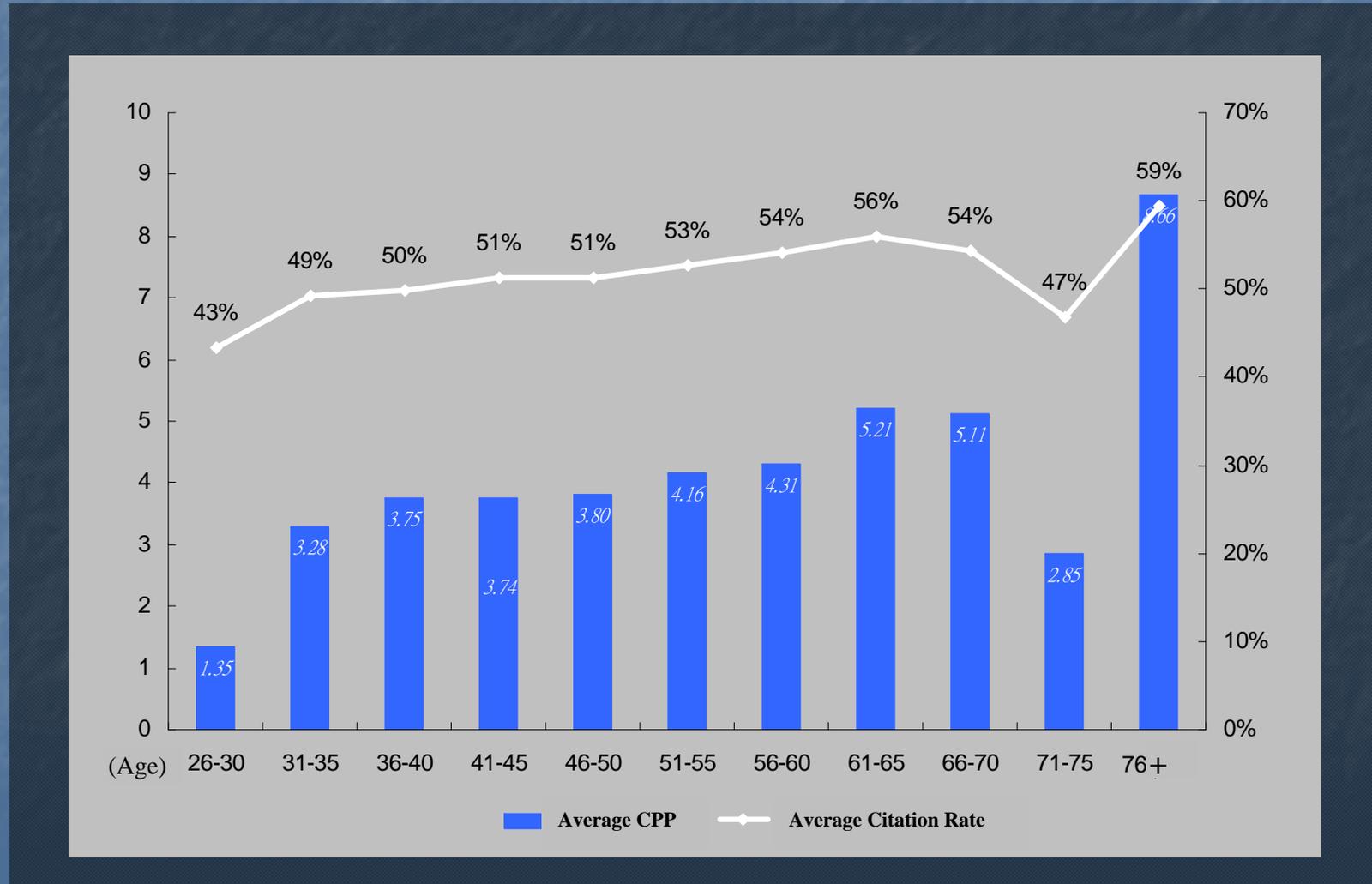
Average CPP and average citation rate in SSCI by years



Average papers in SSCI by age groups



Average CPP and average citation rate in SSCI by age groups



Conclusion I

- Experiences in research projects would be beneficial to accumulate the relationships with other researchers.
- Rather than neither leadership nor social participation for a researcher, the related project experience plays an important role in funding research projects.
- The production of researchers might not have a linear relationship with time span. Researchers in natural science field might have a peak in the middle of his career period, whereas scholars in humanities and social science might have a longer period to reach their career peaks.

Conclusion II

- Investment items rely on subjective judgment. What factors that affect academic productivity are still ambiguous and hard to reach consensus under different research environments.
- By tracing the linkages and network, we are not able to grasp the interactions between scholars, but also help the scholars and authorities look for the main researchers of the relative and complementary knowledge in the field.