

GRADUATE EDUCATION IN TRADITIONAL CHILEAN UNIVERSITIES: A HISTORICAL ANALYSIS

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SUMMARY

Important changes have occurred in higher education in Chile during the past 20 years. During this period, a variety of newly formed private universities have become strong competitors of state-funded traditional universities for undergraduate students. These newer institutions are quite different in quality, focus, and history from the traditional universities. In the early eighties, traditional universities were forced to look for self-financing, and therefore had to compete with private universities for incoming secondary education graduates. As a result, graduate education in the traditional universities has not been able to evolve as expected by taking advantage of the country's growing scientific research potential. Nevertheless, the integrity of traditional universities, and their unquestionable historical strength in basic and applied research, has allowed them to rapidly recover their place and use key strategies to slowly reposition graduate education as one of the main activities distinguishing the highly intellectual Chilean society.

PRELIMINARY REMARKS

In Chile, there are two educational options following completion of a university degree: *postgrado*, equivalent to graduate education in the United States, with a minimum requirement of a bachelor's-type degree (*licenciado*); and *postítulo*, which refers to professional education for jobs such as engineer, teacher, or lawyer. Only the former qualifies a student for research activities.

INTRODUCTION

Since the beginning of this century, due to its homogeneous population, a long-term sustained economic stability, a solid European-based cultural background, and a strong democratic upbringing, Chile has turned out to be a natural leader in Latin America. Among other institutions, its universities have had a crucial role in the structuring, shaping, and strengthening of a highly efficient society, maintained by qualified and competitive professionals. Many of these professionals are world-renowned for their accomplishments. Natural evolution and the need to internationalize academic activities in the early 1950s and

1960s led seven of the most traditional Chilean universities to establish graduate programs in selected competitive areas. These programs were mostly generated as a means of optimizing internal potential as well as to better serve an always-demanding society. Globalization strategies and international quality assessments also led universities to participate in ongoing mobility programs as well as to establish their own programs.

The abrupt disruption of democracy in Chile in 1973 severely fractured the academic community. Exile, combined with central and imposed government control, disrupted the freedom to speak openly and to organize academic activities within the universities. As a result, the previous harmony in academic activities was threatened, seriously hampering the dynamics of day-to-day academic life. Another consequence was that most academic leaders who remained in the country and in their universities ended up sheltered in their own intellectual environments, suffocated by stringent rules and nonparticipative policies. This situation led universities to become partially isolated from their social and natural environment, resulting in a diminished perception of the real needs of a fast-changing society. For 17 years, the country was forced to function under a defined set of general rules and principles wherein intellectual pursuits were not a priority. In the meantime, a well-organized economy created a new generation of youth who cared more for material things and were unmotivated by the more transcendental aspects of life. These historical developments had a clear impact on university life in Chile and especially on the evolution of graduate education.

FROM TRADITIONAL TO PRIVATE UNIVERSITIES IN CHILE

Up to 1980, higher education in Chile was represented by eight traditional universities (table 1 and figure 1) with 118,000 students (for comparison, note that, in 1955, this number was 11,000). These students were mostly undergraduates, and a significant percentage of the university budgets were provided by the state. Under the military regime, a new law was established that restricted state funding for traditional universities. The new scenario created an almost immediate imbalance in the

Chilean higher education system, with an emphasis on undergraduate, rather than graduate, education. The logic behind this strategy was that universities should become self-sustaining from an economic point of view and therefore mainly focused on highly qualified undergraduate formation. As a result, an overwhelming number of new private institutions were created; these developed academic programs primarily oriented to the most attractive and competitive professional careers, and had a “black-board and chalk” basis—i.e., oriented toward careers that did not require laboratories, special facilities, or any type of previous scientific research.

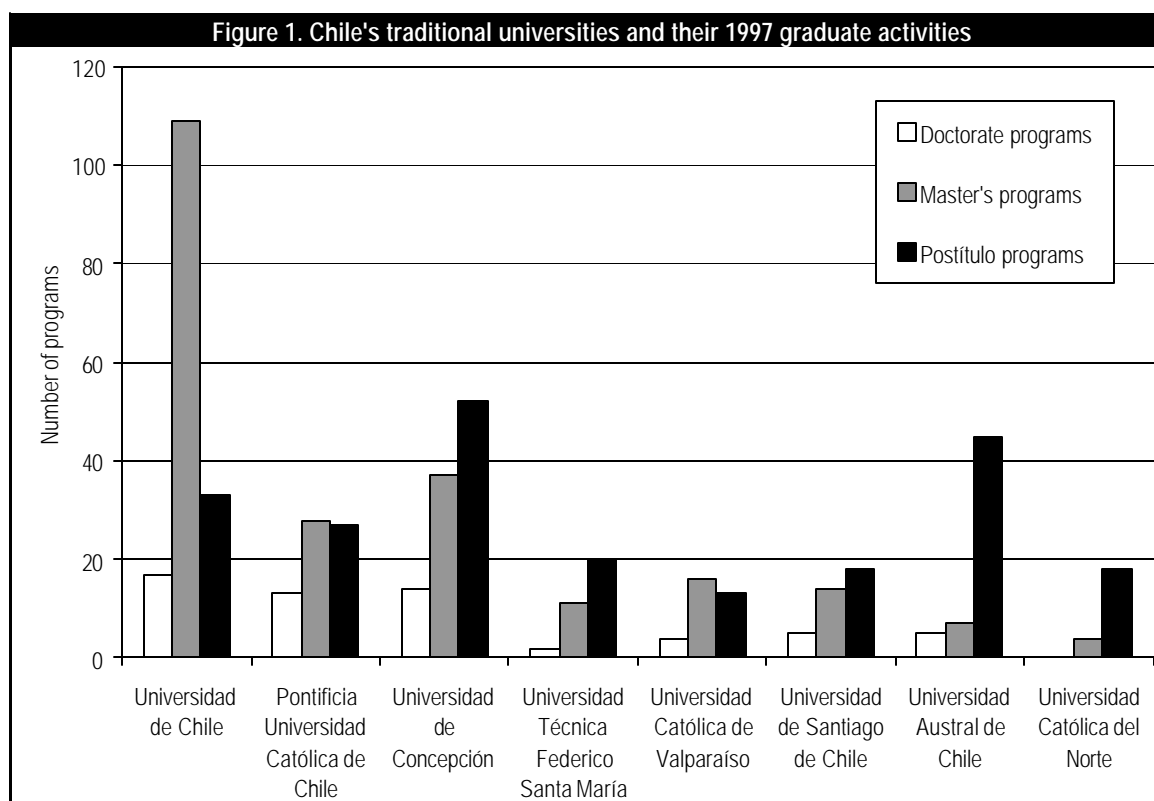
At present, there are around 250 institutions of higher education in Chile distributed as follows: 67 universities (25 traditional, 42 new private); 70 professional institutes; and over 118 technological centers. In all, these have a total of 370,000 officially registered students, of whom 266,000 are university undergraduates (Frei 1998). Almost all of the faculty members associated with these newborn organizations were, and still are, distinguished professors from classical traditional universities hired on a part-time basis for teaching purposes.

When democracy was reinstated in Chile in March 1990, traditional state-funded universities still maintained

Table 1. Chile's traditional universities and their 1997 graduate activities

University	Year of foundation	Doctorate programs	Master's programs	Postítulo programs
Total.....		60	226	226
Universidad de Chile.....	1622	17	109	33
Pontificia Universidad Católica de Chile.....	1888	13	28	27
Universidad de Concepción.....	1919	14	37	52
Universidad Técnica Federico Santa María.....	1926	2	11	20
Universidad Católica de Valparaíso.....	1928	4	16	13
Universidad de Santiago de Chile.....	1947	5	14	18
Universidad Austral de Chile.....	1954	5	7	45
Universidad Católica del Norte.....	1956	0	4	18

SOURCE: Information from individual university Internet (web sites).



SOURCE: Information from individual university Internet (web sites).

their dignity and their standards although their structure was notoriously weakened. The latter was reflected in a less committed, over-middle-aged faculty, and the absolute absence of new faculty positions. Moreover, the new 1980 law stated that the best-ranked 27,500 students applying for university enrollment each year would receive a significant subsidy from the state. This situation occurred under a tight budget, and led traditional universities—besides competing among themselves—to design yearly changing, aggressive strategies for survival as a means of overcoming the uneven competition from private universities for incoming undergraduate students. Thus, the country was not prepared for significant development of graduate training since this simply could not be a priority for traditional universities outnumbered by their private counterparts.

ACTUAL STRUCTURE AND ORGANIZATION OF TRADITIONAL UNIVERSITIES IN CHILE

At present, there are 25 traditional universities in Chile, out of 68 universities in all; these are scattered over the 12 administrative regions of the country plus the metropolitan region that comprises the country's capital. Most of these universities are concentrated in Santiago, the capital city, and in Regions V and VIII (table 2). All traditional universities have in common—to a certain extent—some kind of state support; in contrast, private universities do not. The original eight traditional universities still exist, and all of them have active graduate programs (table 1). Due to the complexity of branch distributions across regions of some of the original universities and the new economic scenario faced by universities in the middle to late 1980s, most regional branches have become autonomous and have acquired new names; nonetheless, they continue to be state-funded just like their progenitors. Something similar happened in the early 1990s to regional branches of Universidad Católica de Chile, the second most important university in the country. This university, although dependent on the Catholic Church (like Universidad Católica de Valparaíso), still receives marginal funding from the state.

The 25 traditional universities are affiliated with the Consejo de Rectores (C.R.), or Council of Rectors, which comprises the rectors of these universities, which are officially recognized by the state; the council is headed by the minister of Education. Besides the rectors, the council has a general secretary who is nominated by the min-

ister of Education and who administers the council's activities. The head of the Department of Higher Education of the Ministry of Education also attends the council sessions as a permanent guest. In the minister's absence, the council is headed by the rector of Universidad de Chile, the first established and strongest university in the country. Foreseeing the need to strengthen graduate activities, the council has, since 1991, had an advisory committee on graduate affairs comprised of all graduate program directors from the 25 member universities. Its objective is to keep this activity alive within these universities and to set quality standards for all programs so they might be recognized internationally. Within this committee, there is an executive commission, composed of all seven university members offering doctorate programs, most of which are accredited by international standards (table 3 and figure 2). At present, this commission is headed by the author of this paper.

GRADUATE ACTIVITIES IN TRADITIONAL UNIVERSITIES

Most C.R. university members offer some kind of graduate programs, although the great majority promote master's over doctorate degree programs. Nonetheless, as a way to promote and maintain regular graduate activities—by themselves expensive—most universities have developed *postítulos*, in which a certificate is granted after 1 to 2 years of advanced specialization courses. In a *postítulo*, no research or thesis work is required for graduation, and the program is mainly oriented to competitive professionals who need to be updated in specific areas of knowledge. Because of their orientation, these programs have a high tuition fee and have become an efficient way to relate to the national productive sector. They have also become an efficient alternative for traditional universities to provide financial support for other academic activities, among them graduate programs. Tables 4, 5, and 6 show the official registration for doctorate, master's, and *postítulo* programs, respectively.

It is clear that the seven leading universities in terms of granting doctorates are also the ones with solid master's and *postítulo* programs. With the exception of Universidad Católica del Norte—one of the eight originals—and its *postítulo* programs (table 6), most activity is concentrated in Santiago and two or three other regions. No doctorate programs are available at any of the private universities, and only a few private universities have MBA-type master's programs—these number fewer than 10 at any one university.

Table 2. Total undergraduate and graduate enrollment in traditional universities, 1997

University/Region	Total	I	II	III	IV	V	VII	VIII	IX	X	XI	XII	RM
Total.....	184,282	7,418	12,553	3,432	6,974	23,181	7,338	27,703	9,475	13,057	0	2,343	70,808
Univ. de Chile.....	21,910	0	0	0	0	0	0	0	0	0	0	0	21,910
P.Univ. Católica de Chile.....	15,821	0	0	0	0	0	0	0	184	0	0	0	15,637
Univ. de Concepción.....	15,124	0	0	0	0	0	0	15,124	0	0	0	0	0
Univ. Católica Valparaíso.....	8,689	0	0	0	0	8,689	0	0	0	0	0	0	0
Univ. T.F. Santa María.....	8,218	0	0	0	0	6,028	0	1,708	0	0	0	0	482
Univ. Santiago de Chile.....	18,295	0	0	0	0	0	0	0	0	0	0	0	18,295
Univ. Austral de Chile.....	9,698	0	0	0	0	0	0	0	0	9,698	0	0	0
Univ. Católica del Norte.....	8,592	0	7,203	0	1,389	0	0	0	0	0	0	0	0
Univ. de Valparaíso.....	4,920	0	0	0	0	4,920	0	0	0	0	0	0	0
Univ. de Antofagasta.....	5,350	0	5,350	0	0	0	0	0	0	0	0	0	0
Univ. de la Serena.....	5,585	0	0	0	5,585	0	0	0	0	0	0	0	0
Univ. del Bio Bio.....	7,779	0	0	0	0	0	0	7,779	0	0	0	0	0
Univ. de la Frontera.....	6,892	0	0	0	0	0	0	0	6,892	0	0	0	0
Univ. de Magallanes.....	2,343	0	0	0	0	0	0	0	0	0	0	2,343	0
Univ. de Talca.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Univ. de Atacama.....	7,204	0	0	3,432	0	0	3,772	0	0	0	0	0	0
Univ. de Tarapacá.....	5,098	5,098	0	0	0	0	0	0	0	0	0	0	0
Univ. Arturo Prat.....	2,350	2,320	0	0	0	0	0	0	30	0	0	0	0
Univ. Metrop. Cs. de la Ed.....	6,549	0	0	0	0	0	0	0	0	0	0	0	6,549
U.P. Ancha Cs. de la Ed.....	3,544	0	0	0	0	3,544	0	0	0	0	0	0	0
U. Tecnol. Metropolitana.....	7,935	0	0	0	0	0	0	0	0	0	0	0	7,935
Univ. de Los Lagos.....	3,359	0	0	0	0	0	0	0	0	3,359	0	0	0
Univ. Católica del Maule.....	3,566	0	0	0	0	0	3,566	0	0	0	0	0	0
Univ. Católica de Temuco.....	2,369	0	0	0	0	0	0	0	2,369	0	0	0	0
Univ. Católica S. Concepc.....	3,092	0	0	0	0	0	0	3,092	0	0	0	0	0
Percentage distribution.....	100.0	4.03	6.81	1.86	3.78	12.58	3.98	15.03	5.14	7.09	0.00	1.27	38.42

KEY: RM = metropolitan region (Santiago)

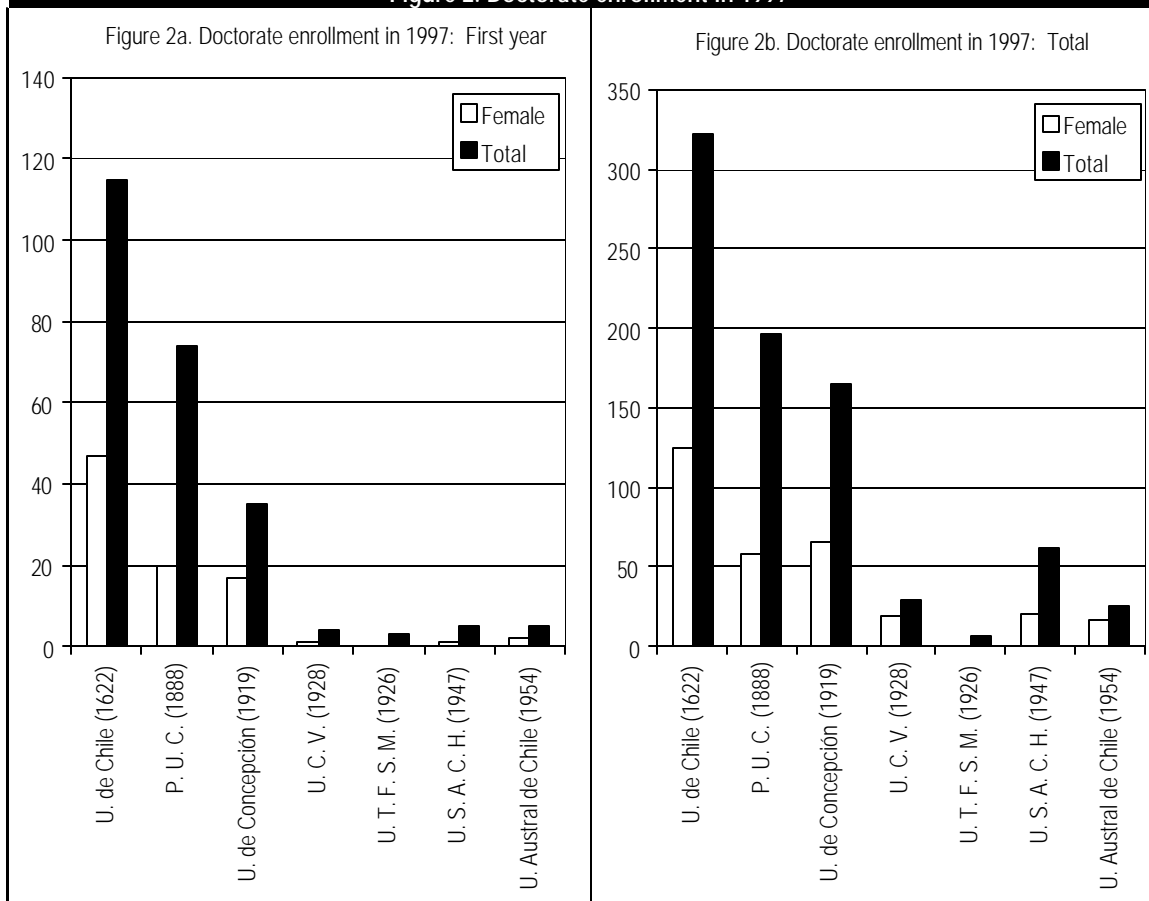
SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Table 3. Doctorate enrollment in 1997

University	First year registration		Total registration	
	Total	Female	Total	Female
Total.....	241	88	807	305
Universidad de Chile.....	115	47	322	125
P. Universidad Católica de Chile.....	74	20	197	58
Universidad de Concepción.....	35	17	165	66
Universidad Católica de Valparaíso.....	4	1	29	19
Universidad T. F. Santa María.....	3	0	6	0
Universidad de Santiago de Chile.....	5	1	62	21
Universidad Austral de Chile.....	5	2	26	16

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Figure 2. Doctorate enrollment in 1997



SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

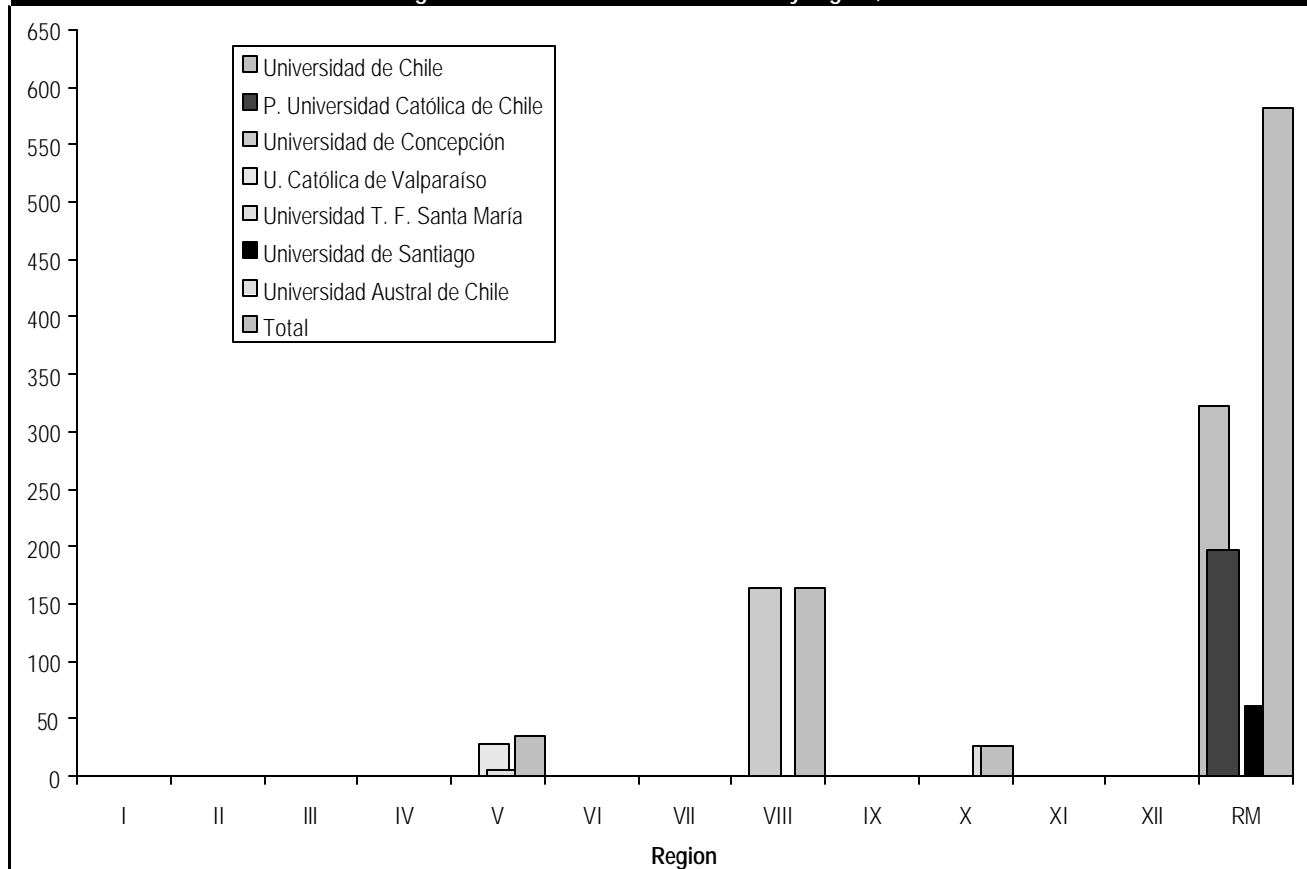
Table 4. Total doctorate enrollment by region, 1997

University/ Region	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	RM
Total.....	807	0	0	0	0	35	0	0	165	0	26	0	0	581
Univ. de Chile.....	322	0	0	0	0	0	0	0	0	0	0	0	0	322
P.Univ. Católica de Chile.....	197	0	0	0	0	0	0	0	0	0	0	0	0	197
Univ. de Concepción.....	165	0	0	0	0	0	0	0	165	0	0	0	0	0
Univ. Católica Valparaíso.....	29	0	0	0	0	29	0	0	0	0	0	0	0	0
Univ. T.F. Santa María.....	6	0	0	0	0	6	0	0	0	0	0	0	0	0
Univ. Santiago de Chile.....	62	0	0	0	0	0	0	0	0	0	0	0	0	62
Univ. Austral de Chile.....	26	0	0	0	0	0	0	0	0	0	26	0	0	0
Percentage distribution.....	100.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	20.4	0.0	3.2	0.0	0.0	72.0

KEY: RM = metropolitan region (Santiago)

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Figure 3. Total doctorate enrollment by region, 1997



KEY: RM = metropolitan region (Santiago)

NOTE: No doctoral enrollment in regions I-IV, VI-VII, IX-X, and XI-XII.

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Table 5. Total master's enrollment by region, 1997

University/Region	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	RM
Total.....	5,442	133	57	47	236	510	0	0	547	245	322	0	22	3,323
Universidad de Chile.....	1,578	0	0	0	0	0	0	0	0	0	0	0	0	1,578
P. Universidad Católica de Chile.....	841	0	0	0	0	0	0	0	0	0	0	0	0	841
Universidad de Concepción.....	547	0	0	0	0	0	0	0	547	0	0	0	0	0
Universidad Católica de Valparaíso.....	147	0	0	0	0	147	0	0	0	0	0	0	0	0
Universidad T. F. Santa María.....	91	0	0	0	0	91	0	0	0	0	0	0	0	0
Universidad de Santiago de Chile.....	312	0	0	0	0	0	0	0	0	0	0	0	0	312
Universidad Austral de Chile.....	316	0	0	0	0	0	0	0	0	0	316	0	0	0
Universidad Católica del Norte.....	75	0	57	0	18	0	0	0	0	0	0	0	0	0
Universidad de Valparaíso.....	73	0	0	0	0	73	0	0	0	0	0	0	0	0
Universidad de la Serena.....	218	0	0	0	218	0	0	0	0	0	0	0	0	0
Universidad de la Frontera.....	245	0	0	0	0	0	0	0	0	245	0	0	0	0
Universidad de Magallanes.....	22	0	0	0	0	0	0	0	0	0	0	0	22	0
Universidad de Atacama.....	47	0	0	47	0	0	0	0	0	0	0	0	0	0
Universidad de Tarapacá.....	133	133	0	0	0	0	0	0	0	0	0	0	0	0
U. Metropolitana de Cs. De la Ed.....	592	0	0	0	0	0	0	0	0	0	0	0	0	592
U. De Playa Ancha Cs. De la Ed.....	199	0	0	0	0	199	0	0	0	0	0	0	0	0
Universidad de los Lagos.....	6	0	0	0	0	0	0	0	0	0	6	0	0	0
Percentage distribution.....	100.0	2.4	1.0	0.9	4.3	9.4	0.0	0.0	10.1	4.5	5.9	0.0	0.4	61.1

KEY: RM = metropolitan region (Santiago)

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Table 6. Total *postítulo* enrollment by region, 1997

University/Region	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	RM
Total.....	10,091	175	2,644	97	117	1,084	50	572	1,188	280	936	0	0	2,948
Universidad de Chile.....	1,019	0	0	0	0	0	0	0	0	0	0	0	0	1,019
P. Universidad Católica de Chile.....	871	0	0	0	0	0	0	0	0	70	0	0	0	801
Universidad de Concepción.....	511	0	0	0	0	0	0	0	511	0	0	0	0	0
Universidad Católica de Valparaíso.....	415	0	0	0	0	415	0	0	0	0	0	0	0	0
Universidad T. F. Santa María.....	1,127	0	0	0	0	459	50	0	159	0	0	0	0	459
Universidad de Santiago de Chile.....	365	0	0	0	0	0	0	0	0	0	0	0	0	365
Universidad Austral de Chile.....	745	0	0	0	0	0	0	0	0	0	745	0	0	0
Universidad Católica del Norte.....	2,687	0	2,644	0	43	0	0	0	0	0	0	0	0	0
Universidad de Valparaíso.....	136	0	0	0	0	136	0	0	0	0	0	0	0	0
Universidad de la Serena.....	74	0	0	0	74	0	0	0	0	0	0	0	0	0
Universidad de la Frontera.....	210	0	0	0	0	0	0	0	0	210	0	0	0	0
Universidad de Atacama.....	97	0	0	97	0	0	0	0	0	0	0	0	0	0
Universidad de Tarapacá.....	175	175	0	0	0	0	0	0	0	0	0	0	0	0
U. Metropolitana de Cs. De la Ed.....	304	0	0	0	0	0	0	0	0	0	0	0	0	304
U. De Playa Ancha Cs. De la Ed.....	74	0	0	0	0	74	0	0	0	0	0	0	0	0
Universidad de los Lagos.....	191	0	0	0	0	0	0	0	0	0	191	0	0	0
Universidad Católica del Maule.....	572	0	0	0	0	0	0	572	0	0	0	0	0	0
Universidad Católica S. Concepción.....	518	0	0	0	0	0	0	0	518	0	0	0	0	0
Percentage distribution.....	100.0	1.7	26.2	1.0	1.2	10.7	0.5	5.7	11.8	2.8	9.3	0.0	0.0	29.2

KEY: RM = metropolitan region (Santiago)

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

There are significant differences among the 25 C.R. member universities in their experience in graduate education activities. Graduate activity in Chile constitutes a natural heritage of traditional universities. Out of the 25, 7 universities offer doctorate programs, 17 offer master's programs, and 18 offer *postítulo* programs (tables 1, 3, 4, 5, and 6). Most programs show a reasonable degree of efficiency, as measured by the number of graduates in each type of program. Table 7 shows the 1997 official data for graduation in doctorate programs. Table 8 does the same for master's programs. When comparing the number of candidates in doctorate programs (table 3) against the number of graduates (table 7), the yearly av-

erage graduation is 5 to 10 percent of all enrolled students. As expected, the average graduation frequency for master's programs (tables 5 and 8) is much higher, reaching levels up to 20 percent per year.

The core of qualified graduate programs lies in traditional universities, which are outnumbered by their private counterparts. Internationally competitive graduate programs occur almost exclusively at the doctorate level. Only 7 of Chile's 68 universities participate at this level, offering 60 different programs, most of which are fully accredited either nationally or—in a few cases—internationally. College-level activity in all traditional universities

Table 7. Total doctorate degrees granted, 1997

University/Area	Total	Agronomy	Art	Sciences/ mathematics	Social sciences	Law	Humanities	Education	Technology	Health
Total.....	57	0	0	45	0	0	1	3	0	8
Universidad de Chile.....	26	0	0	18	0	0	0	0	0	8
P. Universidad Católica de Chile.....	12	0	0	8	0	0	1	3	0	0
Universidad de Concepción.....	7	0	0	7	0	0	0	0	0	0
Universidad Católica de Valparaíso.....	4	0	0	4	0	0	0	0	0	0
Universidad de Santiago de Chile.....	2	0	0	2	0	0	0	0	0	0
Universidad Austral de Chile.....	6	0	0	6	0	0	0	0	0	0
Percentage distribution.....	100.0	0.0	0.0	78.9	0.0	0.0	1.8	5.3	0.0	14.0

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

Table 8. Total master's degrees granted, 1997

University/Area	Total	Agronomy	Art	Sciences/ mathematics	Social sciences	Law	Humanities	Education	Technology	Health
Total.....	648	35	5	95	197	4	59	134	76	43
Universidad de Chile.....	201	14	3	29	67	0	20	4	24	40
P. Universidad Católica de Chile.....	173	14	2	9	98	4	10	8	28	0
Universidad de Concepción.....	53	1	0	19	6	0	8	8	8	3
Universidad Católica de Valparaíso.....	18	0	0	7	0	0	5	4	2	0
Universidad T. F. Santa María.....	13	0	0	2	0	0	0	0	11	0
Universidad de Santiago de Chile.....	31	0	0	2	14	0	11	1	3	0
Universidad Austral de Chile.....	36	5	0	22	7	0	2	0	0	0
Universidad Católica del Norte.....	5	0	0	5	0	0	0	0	0	0
Universidad de la Serena.....	51	1	0	0	0	0	0	50	0	0
Universidad de la Frontera.....	5	0	0	0	5	0	0	0	0	0
Universidad de Magallanes.....	2	0	0	0	0	0	0	2	0	0
Universidad de Tarapacá.....	22	0	0	0	0	0	0	22	0	0
U. Metropolitana de Cs. De la Ed.....	29	0	0	0	0	0	2	27	0	0
U. De Playa Ancha Cs. De la Ed.....	6	0	0	0	0	0	1	5	0	0
Universidad de Antofagasta.....	3	0	0	0	0	0	0	3	0	0
Percentage distribution.....	100.0	5.4	0.8	14.7	30.4	0.6	9.1	20.7	11.7	6.6

SOURCE: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1997).

has had to increase heavily in the last 10 years and has been forced to perform at a level of high efficiency in terms of graduates. This has not been the case for graduate education, which annually graduates 2 doctorate students per million inhabitants, not counting those graduating abroad. This is quite a low figure when compared to 10 in Brazil and 150 in the United States (Zumelzu 1997).

After this rather somber evaluation, one might question why such an evolution has occurred—and even wonder how graduate activity has survived. The main answer to both questions is that traditional universities in Chile know, and have known for a long time, that without graduate activity, a strong, complex university cannot survive. In addition, Chile is very much aware that a reduced scientific mass necessarily undermines the future of science and, to a lesser degree, technology; therefore, it is the responsibility of its universities to generate, maintain, and renew the scientific and technically trained personnel sustaining the country. Certainly, graduate education is one of the pivotal instruments required to achieve these objectives.

THE RESEARCH MISSION SUPPORTING GRADUATE EDUCATION

Today, the organized body of knowledge that makes it possible to understand the causes of verifiable phenomena (science) and the application of knowledge to the production of goods and services (technology) permeates all sectors and activities of society (Mayorga 1997). There are many areas in which the spheres of science and technology and the socioeconomic development of any country overlap. Universities should act as interfaces to harmonize the process, providing not only knowledge, but also—and most importantly—the actors. In recent years, as discussed previously, significant changes in the university environment have affected the research-related missions of these institutions and, as a consequence, their approach to graduate education. In particular, universities are becoming more diverse in structure and more oriented toward economic and industrial needs, while coping with year-to-year higher college-level student enrollment. On the other hand, government budgets to support

traditional universities, as well as those related to research and development (R&D), are increasing very slowly and at a percentage not comparable to those of developed countries. Table 9 shows the percentage of the gross domestic product (GDP) invested in R&D in Chile starting in 1965 and the estimated rate expected at the year 2000.

Table 9. Percentage of Chile's GDP invested in R&D, 1965-2000		
Year	R&D expenditures (Mil. US Dollars)	Percent
1965.....	0.02	0.32
1966.....	0.02	0.35
1967.....	0.03	0.41
1968.....	0.03	0.42
1969.....	0.03	0.39
1970.....	0.03	0.39
1971.....	0.05	0.49
1972.....	0.06	0.51
1973.....	0.04	0.41
1974.....	0.04	0.33
1975.....	27.00	0.37
1976.....	39.29	0.40
1977.....	57.61	0.43
1978.....	76.21	0.49
1979.....	82.56	0.40
1980.....	107.59	0.39
1981.....	123.86	0.38
1982.....	108.91	0.45
1983.....	96.20	0.49
1984.....	99.30	0.52
1985.....	80.16	0.50
1986.....	81.02	0.48
1987.....	104.76	0.55
1988.....	108.35	0.45
1989.....	131.01	0.47
1990.....	161.95	0.53
1991.....	183.34	0.53
1992.....	248.58	0.58
1993.....	286.82	0.63
1994.....	340.49	0.65
1995.....	430.37	0.64
1996.....	454.98	0.66
1997.....	528.34	0.69
1998.....	678.28	0.84
1999.....	850.93	0.98
2000.....	1,005.04	1.09

SOURCE: Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), Santiago, Chile.

These data suggest that, in the near future, sustainability of traditional universities will become more and more dependent upon the annual fees paid by undergraduate students and, to a lesser extent, upon any lateral activities they could perform in the areas of applied research, technical assistance, training courses or programs, and knowledge and technology transfer to the productive sectors of the economy. These trends undoubtedly raise serious questions about how to ensure that universities can continue to make their unique contribution to long-term basic research—a pivotal and unavoidable key component supporting graduate activities inside established universities. Unfortunately, these are considered unprofitable activities with high unit cost to achieve graduation for a small number of students, where external support is limited and scholarships scarce. Therefore, traditional Chilean universities, as elsewhere, must adapt to this reality in largely positive ways, evolving toward new roles and configurations to properly face the needs of the 21st century. One example of this trend is the fact that, with declining government support, there is an obvious need not only to seek new sources of funds but also to establish a new basis for that support. One appealing strategy applied in Europe (OECD 1998), and which could be applicable in Chile, would be to change the nature of government funding to make it mission-oriented, contract-based, and more dependent on output and performance criteria. If applied, this would lead universities to perform more short-term and market-oriented research.

FINANCING R&D ACTIVITIES: COMPETITIVE FUNDS FOR RESEARCH

It has been already stated that research is essential in supporting qualified graduate programs, and vice versa. It is also well known that, in order to do that, external funding is a must. Therefore, an indirect way to examine the efficiency of graduate activity in a country is to analyze the economic resources invested in R&D as a percentage of GDP (UNESCO 1993) and identify where the research activity occurs. The low level of R&D funding helps explain the low level of graduate formation in the country. Chile used only 0.7 percent of its GDP in 1994 in this area, compared with 0.8 percent in Argentina, 0.9 percent in Brazil, and 2.77 percent in the United States (Zumelzu 1997). The main reason for this is that most of the research performed in Chile occurs in universities. Table 10 shows that, for the last 15 years, on average, almost 70 percent of all researchers work at uni-

versities; this might be interpreted as meaning that the productive sector is not involved or not interested in developing its own research potential. Table 11 further suggests that this might be the case. Over 70 percent of R&D done in the country is performed at universities, mostly—but not exclusively—by graduates. Table 10 also shows that the industrial sector has a negligible participation; in addition to universities, most market-oriented re-

search is done at professional institutes supported by the state where graduate training is not at all considered.

To do highly competitive and consistent research, funding is fundamental; to get this funding appears to be the sole responsibility of each researcher through state-provided competitive funds. Since graduate programs normally require an experimental thesis for graduation, it is also the responsibility of the research advisor to provide the required financial support. This is indeed the case, and can be inferred from figure 4, where the most relevant state-provided competitive funds are summarized. It can be clearly seen in the figure that the only direct support for the development of graduate education corresponds to graduate student fellowships, representing a low 4 percent of the total. This support is restricted to accredited programs. In the figure, Fondecyt is a research fund that supports single principal investigators; Fondef, an equivalent supporting institution, generally supports universities in association with industries. Thus, the only real sources of money to carry out graduate work are indirect and unstable, depending on researchers to provide them.

To understand these data in a more general context, a closer analysis of the steady-state annual national budget distribution in the field might help. As an example, in 1997 the national R&D expense reached US\$480 million. From this lump sum, 70 percent (US\$336 million) corresponded to state expenditure, and 23 percent (US\$110 million) to enterprise expenditure. Of the state expenditure, 26 percent (US\$87 million) was competitive funds,

Table 10. Total researchers at universities

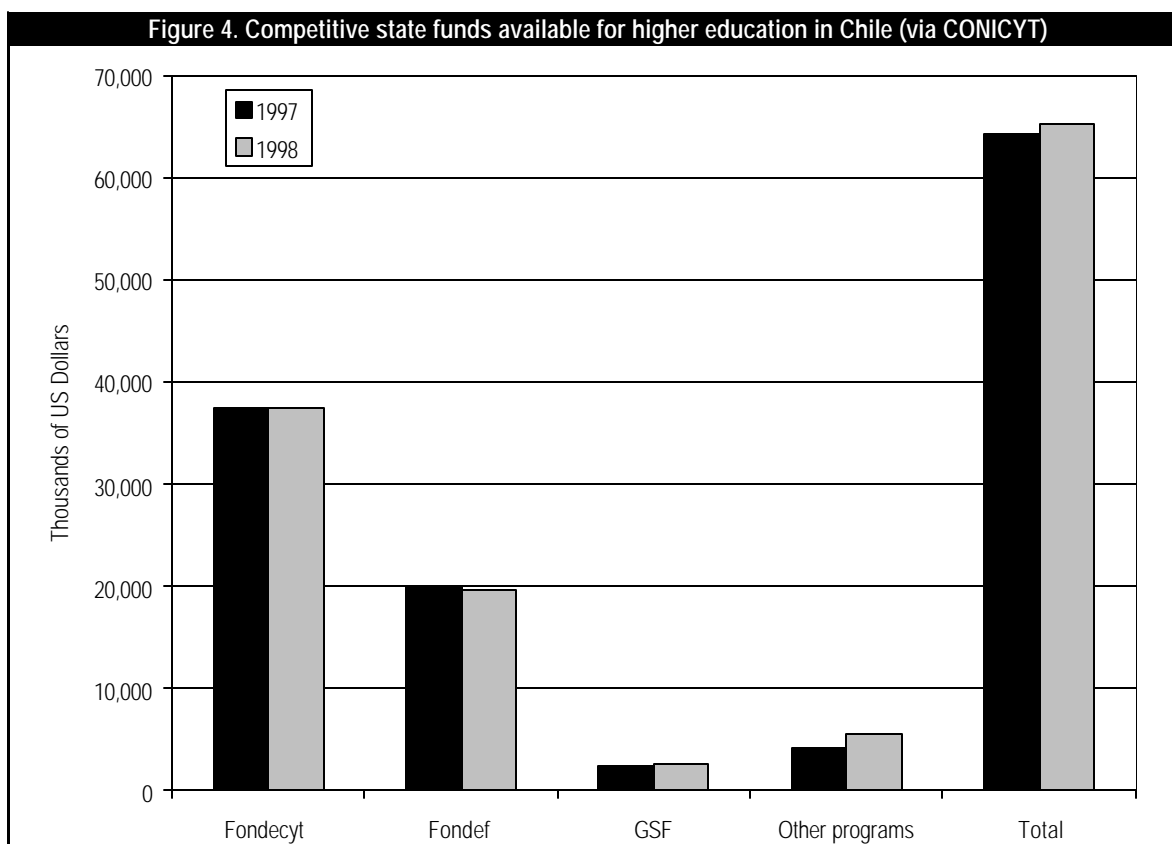
Year	Total in Chile	Researchers in universities	Percent at universities
1981.....	3,420	2,434	71.2
1982.....	3,547	2,561	72.2
1983.....	3,727	2,677	71.8
1984.....	3,886	2,789	71.8
1985.....	4,079	2,924	71.7
1986.....	4,251	3,056	71.9
1987.....	4,588	3,169	69.1
1988.....	4,803	3,279	68.3
1989.....	5,115	3,389	66.3
1990.....	5,421	3,609	66.6
1991.....	5,628	3,710	65.9
1992.....	5,860	3,942	67.3
1993.....	6,028	4,029	66.8
1994.....	6,223	4,168	67.0
1995.....	6,388	4,356	68.2
1996.....	6,619	4,583	69.2

SOURCES: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1981 a 1996). Information submitted directly by universities and institutes; Department of Information, Comisión Nacional de Investigación Científica y Tecnológica (CONICYT).

Table 11. Graduate involvement in the national R&D system

Year	Total researchers	Total graduates	Universities	Professional institutes	Industry	Percent of graduates
1981.....	3,420	2,314	2,239	75	none	67.6
1982.....	3,547	2,408	2,325	83	none	67.8
1983.....	3,727	2,718	2,633	85	none	72.9
1984.....	3,886	2,884	2,793	91	none	74.2
1985.....	4,079	3,213	3,111	102	none	78.8
1986.....	4,251	3,551	3,440	111	none	83.5
1987.....	4,588	3,667	3,541	126	none	79.9
1988.....	4,803	3,631	3,484	131	16	75.6
1989.....	5,115	3,833	3,677	137	19	74.9
1990.....	5,421	3,775	3,628	147	none	69.6
1991.....	5,628	3,815	3,661	154	none	67.8
1992.....	5,860	3,869	3,692	177	none	66.0
1993.....	6,028	3,884	3,692	192	none	64.4
1994.....	6,223	4,455	4,259	196	none	71.6
1995.....	6,388	4,926	4,730	196	none	77.7
1996.....	6,619	5,153	4,957	196	none	77.9

SOURCE: Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), Santiago, Chile.



SOURCE: Comisión Nacional de Investigación Científica y Tecnológica (CONICYT), Santiago, Chile.

31 percent (US\$104 million) was the state direct allowance shared by the 25 traditional universities, and 17 percent (US\$57 million) was the direct subsidy the state provides for its technological institutes (Frei 1998 and Santibañez 1998). It is appropriate to say, at this point, that the direct state allowance received by traditional universities is not evenly distributed; it varies widely based on a number of factors. Therefore, and as already mentioned, a minimum amount of this fund goes to graduate students—mainly as fellowships—and not in direct support of experimental research.

THE SITUATION IN SCIENCE AND ENGINEERING

Most graduate programs in traditional universities deal with basic sciences and mathematics rather than with engineering. This may be one of the factors underlying the weak relationship existing between universities and the productive sector. Engineering is an activity that builds on sciences, techniques, and arts to improve and diversify the production of good and services, contributing in this way to societal satisfaction. The relationship of empirical engineering with basic sciences to make up what is cur-

rently known as “engineering sciences” is a rather recent phenomenon; therefore, the development of graduate activities has naturally been delayed in relation to basic sciences. This is the situation in Chile, where the universe of people and organizations devoted to research in this field is not very large nationwide. Fewer than 15 percent of all graduate programs currently in progress in Chile correspond to engineering and related areas. Table 12 shows the distribution of scientists and engineers involved in research in Chile, where engineers represent about 30 percent of the total. The difference is even higher when the analysis is limited solely to universities. Table 13 shows that, in the last 15 years, the proportion of engineers among researchers at universities has declined from over 16 percent to less than 14 percent. This is an evident sign of the already discussed tendency of graduates to prefer the private sector to universities.

Table 14 shows that the number of scientists and engineers per 1,000 population has increased modestly from 0.9 in 1981 to 1.2 in 1996.

Although the representation of engineers in research—and, as a consequence, in graduate activities—is low, their efficiency might be high. To test this hypoth-

Table 12. Scientists and engineers involved in research in Chile

Year	Total number of researchers	Scientists		Engineers	
		Number	Percent	Number	Percent
1981.....	3,420	2,369	64.3	1,051	30.7
1982.....	3,547	2,488	70.1	1,059	28.9
1983.....	3,727	2,632	10.6	1,095	29.4
1984.....	3,886	2,739	70.5	1,147	29.5
1985.....	4,079	2,873	70.4	1,206	29.6
1986.....	4,251	3,000	70.6	1,251	29.4
1987.....	4,588	3,174	69.2	1,414	30.8
1988.....	4,803	3,222	67.1	1,581	32.9
1989.....	5,115	3,427	67.0	1,688	33.0
1990.....	5,421	3,669	67.7	1,752	32.3
1991.....	5,628	3,784	67.2	1,844	32.8
1992.....	5,860	3,979	67.9	1,881	32.1
1993.....	6,028	4,055	67.9	1,973	32.8
1994.....	6,223	4,177	67.1	2,046	32.9
1995.....	6,388	4,350	68.1	2,038	31.9
1996.....	6,619	4,552	71.3	2,067	31.2

NOTE: The engineers included here are those who perform research.

SOURCES: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1981 a 1995); and Departamento de Información y Departamento de Estudios, CONICYT, Chile.

Table 13. Percentages of scientists and engineers at universities

Year	Total number of researchers	Scientists		Engineers	
		Number	Percent	Number	Percent
1981.....	2,434	2,035	83.6	399	16.4
1982.....	2,561	2,153	84.0	408	16.0
1983.....	2,677	2,260	84.4	417	15.6
1984.....	2,789	2,363	84.7	426	15.3
1985.....	2,924	2,489	85.1	435	14.9
1986.....	3,056	2,612	85.5	444	14.5
1987.....	3,169	2,716	85.7	453	14.3
1988.....	3,279	2,817	85.9	462	14.1
1989.....	3,389	2,918	86.1	471	13.9
1990.....	3,609	3,117	86.4	493	13.7
1991.....	3,710	3,206	86.4	504	13.6
1992.....	3,942	3,406	86.4	536	13.6
1993.....	4,029	3,472	86.2	558	13.8
1994.....	4,168	3,589	86.1	580	13.9
1995.....	4,356	3,755	86.2	601	13.8
1996.....	4,583	3,960	86.4	623	13.6

SOURCES: Consejo de Rectores de las Universidades Chilenas, *Anuario Estadístico* (Santiago, Chile, 1981 a 1995); and Departamento de Información y Departamento de Estudios, CONICYT, Chile.

Table 14. Total scientists and engineers per 1,000 population

Year	Active population (Thousands)	Scientists and engineers	Per / 1,000
1981.....	3,815.1	3,420	0.90
1982.....	3,897.4	3,547	0.91
1983.....	4,127.3	3,727	0.90
1984.....	4,174.5	3,886	0.93
1985.....	4,239.3	4,079	0.96
1986.....	4,346.9	4,251	0.98
1987.....	4,392.3	4,588	1.04
1988.....	4,551.6	4,803	1.06
1989.....	4,674.6	5,115	1.09
1990.....	4,728.6	5,421	1.15
1991.....	4,794.1	5,628	1.17
1992.....	4,990.4	5,860	1.17
1993.....	5,219.3	6,028	1.16
1994.....	5,299.5	6,223	1.17
1995.....	5,538.2	6,388	1.15
1996.....	5,776.9	6,619	1.15

SOURCES: Instituto Nacional de Estadísticas, INE, *Anuarios Estadísticos*, años: 1984 a 1994, Santiago, Chile; Banco Central de Chile, *Boletines Mensuales*, años: 1984 a 1996 Santiago, Chile; Consejo de Rectores, *Anuarios Estadísticos*, años: 1982 a 1995; and Departamento de Información y Departamento de Estudios, CONICYT, Chile.

esis, one reasonable way to analyze the productivity level of engineering sciences and technology research in a developing country like Chile would be to look into indexed mainstream articles at the Institute of Scientific Information (ISI) over a defined period of time (Zumelzu 1997).

Such an analysis allows one to quantify and evaluate research activities in a given field, which indirectly may be a basic reflection of graduate activities performed in a given country. According to ISI data, the contribution of Latin American countries to indexed scientific publications accounts for only 1.3 to 1.8 percent of the world's total; of this, Brazil, Argentina, Mexico, and Chile represent a solid 85 percent of Latin America's contribution (Appenzeller 1995). When considering the number of publications per million inhabitants, Chile occupies the first place, followed by Argentina (Ayala 1995). In contrast, Latin American engineering publications, when compared

to other disciplines, do not exceed 5 percent of the total, of which Chile has the lowest impact (Krauskopf et al. 1995).

FINAL REMARKS

This presentation updates as well as summarizes the most relevant issues that have defined the state of development of graduate education in Chile. Although its standards remain high, graduate education has a low representation in university life in Chile. To increase its prominence as a key instrument for social and technical development, stronger support from the state is required, in close association with traditional universities and—hopefully—the private sector as well. A 5-year state program supported by the World Bank oriented to graduate education is in the process of being implemented in Chile, thus providing new reason for optimism.

ACKNOWLEDGMENTS

I am grateful to Carmen Garces and Mauricio de Valparaiso for their help in editing this paper. Velasquez from Biblioteca Central Universidad Catolica

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