Postgraduate programmes and specializations in ICT: the effects of enterprise characteristics on postgraduates' employment

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Abstract

The analysis of the relationships between the higher education and the labour market in the field of information and communications technologies (ICT) presents particular interest due to their rapid development and significant impact. This paper focuses on the analysis of the effects of enterprise profile characteristics on the employment of ICT postgraduates. Firstly, the provided ICT postgraduate programmes are presented by examining several issues such as the specializations offered, their evolution and geographical allocation as well as the taught subjects. The main analysis is based on the responses on a national survey addressed to all ICT enterprises residing in Greece. Random sampling yielded nearly 350 filled questionnaires corresponding to a response rate of over 30%. The statistical analysis concentrates on the impacts of enterprise characteristics on the adopted employment and preference policies as well as their estimations about the specialization need, demand and extent. According to the research findings the enterprise size, the location and some of their vocational directions affect significantly their practices and expectations.

Introduction

The recent development of the postgraduate programmes (PPs) related to the information and communications technologies (ICT) is impressive. One of the main reasons for the rapid growth of their number is the close relationship with the labour market needs as it has been detected that the employability of postgraduates in ICT is in many countries high. Certain researchers argue that appropriate PPs can operate as an effective tool for the improvement of

the matching procedures between the graduates' skills and the labour market's needs for the existence of a well trained and effective workforce (Cohen and Tyson 1989). Other papers ascertain the existence of a strong relationship between the market's demand and the skills acquired by the postgraduates in the ICT field (Levin and Rumberger 1985, Carnoy 1997).

This paper is concerned with the association of the postgraduate education in ICT with the labour market. The research conducted focuses on both; the analysis of provided PPs in Greece and the effects of labour market's characteristics on postgraduates' employment. This work's main objective is the extensive investigation of the differentiations of enterprise policies and estimations according to their profile characteristics.

With regard to the contents of this paper, an extensive literature review follows in this introductory section. The evolution of the provided postgraduate programmes and specializations is analyzed and relevant findings are commented in the next (second) section. The third section of the paper is concerned with the analysis of research objectives and scientific contribution. The next (fourth) section deals with the methodology adopted, describing also the procedure of data collection. The fifth, paper's main section presents the principal results. It is divided in four subsections analysing the profile characteristics of the ICT enterprises, their employment and preference policies, the labour market's estimations and the statistically significant effects of companies' characteristics on postgraduate's employment respectively. Overall conclusions are finally presented and relevant future work is proposed.

The era of the digital revolution has influenced remarkably the educational planning as well as the labour market. Recent developments have shown that a close relationship with the labour market needs can afford a high reliability to the PPs, especially those related with the new technologies (Carnoy 1997).

The European Commission points out that the unprecedented recent technological rearrangements will have direct impact in the labour market regarding the demand of specialized personnel in the ICT sector. On the one hand information society has increased the demand for high-skilled workforce and on the other the majority of European companies feel impeded by the lack of skills within their organization (European Commission 2000).

A relative work of Freeman and Aspray detects that the growing trends of PPs in USA will be continued. Nevertheless a different increase pace of the professional and the research degrees has been noticed during the decade of 1990s: 9% growth in the number of Master's programmes and nearly 19% in that of the doctoral ones (Freeman and Aspray 1999). Similar estimations reappear in two recent reports to the Unites States Congress (Meares and Sargent 1999, U.S. Department of Commerce 2003). Moreover a recent work examining the demand for graduates argues that their continuously growing number can readily be accommodated by the enterprises (Aston and Bekhradnia 2004).

It has also been indicated that there is a significant gap between employees' skills and competencies and the employers' needs (Bibby 2000). Other researchers have noticed the existence of a raising danger of an increasing skills mismatch and, moreover, a shortage of highly skilled employees that is faced by the ICT enterprises. The present situation of the ICT sectoral labour market causes a danger for the companies to loose pace in market competition and/or to be pushed to raise the salaries, especially those of highly skilled workforce (Latniak and Schmidt-Dilcher 2000). Moreover, the Canadian case indicates that more than 50% of the enterprises experienced hiring challenges due to the lack of qualified employees with the necessary skills or experience. Additionally a 35% of vacant ICT positions remained unfilled for more than four months (Software Human Resource Council 2001).

A similar skills gap exists also in Greece. The Greek Economic and Social Committee has mentioned that there is a lack of high skilled workforce supply in the local ICT sector with a number of about 50,000 relevant vacant positions (Greek Economic and Social Committee 2002). Certain findings of the International Data Corporation for Europe forecasted that for the year 2003 the ICT skills shortage in Greece will be about 11%, that is to say more than 2000 persons (Bibby 2000).

The presentation of the postgraduate programmes and specializations is based on quantitative data analysis, whereas the investigation of the effects of the enterprise characteristics on their policies for postgraduates' employment on the results of a recent national survey addressed to the ICT enterprises residing in Greece.

ICT postgraduate programmes and specializations in Greece

The pressures of the rapidly growing Greek ICT labour market during the decade of '90s and the high demand for specialization led to an impressive development of the relevant postgraduate programmes. Furthermore the majority of hi-tech enterprises have expressed their willingness to recruit skilled employees (Kostoglou et al. 2004a). The following analysis examines the provided specializations, the evolution since the establishment of the oldest PP, the geographical allocation and some other relevant issues.

At the end of year 2004, 21 PPs offering 51 postgraduate specializations directly relative with ICT are provided by several departments of Greek Universities (Kostoglou 2004b). Figure 1 presents the categorization of the postgraduate specializations and shows that Information Technology (31% of their total number), Informatics and Communications (26%) and Computer Science (23%) are the dominant ones.

-Insert Figure 1 here-

Figure 2 shows the progressive increase in the number of PPs during the last 12 years with more significant rises of the new-established programmes during three successive two-year time periods (1993-1994, 1997-1998 and very recently at 2003-2004). The main cause for these rises is the European Union's financing by the three consecutive Community Support Frameworks.

-Insert Figure 2 here-

A worthy of mention characteristic is the geographical allocation of the provided PPs: seven of them operate in Athens (33%), four in Thessaloniki and in Patra (19% each) and only six in the rest of the country (29%).

Further quantitative analysis lead to some more interesting findings:

1) Studies duration

The duration of the postgraduate studies is constrained by the relevant legislation. The minimum duration imposed by the law is four semesters; nevertheless it varies significantly between the various PPs. The studies in the majority of the provided programmes (64%) last six semesters, in only 9% of them last five semesters and in the remaining programmes (27%) last four semesters. The average study duration is 2.7 academic years. In all PPs the last two semesters are devoted for the preparation of the postgraduate thesis.

2) Taught subjects

A detailed analysis of the corresponding course programmes shows that in total 301 different subjects are offered by the 51 existing postgraduate specializations. This variety proves the pluralism of the PPs in comparison with the noted uniformity of the undergraduate ICT programmes (Kostoglou and Paparrizos, 2004c).

The need for the best possible data elaboration led to the allocation of the provided postgraduate courses in distinct categories according to their content and specialization.

Table 1 includes all identified course categories as well as the numbers - totals and means - of the corresponding postgraduate subjects.

-Insert Table 1 here-

Courses related to “automation - robotics - knowledge systems”, “hardware technology” and “networks and telecommunications” are the most popular among the 16 distinct course categories. However, significant dissimilarities are noted regarding the number of taught subjects in every one of the postgraduate programmes. Their number varies from 5 to 29 subjects per PP (mean = 13.1 and st. dev. = 6). Also the majority of the PPs (12 out of the 21) offer more than one postgraduate specialization (mean = 2.4).

3) Postgraduate students

The current (year 2004) annual number of postgraduate students is approximately 700, having been doubled since 2002 and corresponding to nearly 10% of the total number of undergraduate ICT students in Greece. The average proportion between educational staff and postgraduate students and is much lower than this of the ICT undergraduate programmes (1:1.1 against 1:26 respectively).

Conclusively, the identified causes for the recent development of these PPs in Greece are the labour market’s needs for specialized “digital” workforce, the high demand for postgraduate studies by the undergraduates and the EU financing for the establishment and operation of such programmes. However the limited number of graduate students did not contribute yet substantially to the lowering of the skills gab in the Greek ICT sector and further increase of their number is expected.

Research objectives and contribution

The employment of educational outflows is undoubtedly a complex issue depending on numerous parameters. It is thus probably not possible examining all of them simultaneously. This paper focuses on the investigation of the effects of the enterprise characteristics on the employment of postgraduates in the ICT sector. The main issues examined are the enterprise employment and preference policies as well as the sectoral labour market's estimations regarding the needs and the demand for postgraduate specialization.

This work's main objective is to study the differentiations of the above policies and opinions in relation to enterprise profile characteristics. Survey's results and conclusions deduced are novel as the corresponding national survey to ICT enterprises is the first of its kind. Furthermore the examination of the impacts of enterprise profile on employment is an issue that has been studied very scarcely so far. Regarding its practical contribution in the advance of knowledge this work can also be useful for audience of several countries having similar economic characteristics and/or degree of ICT accession with Greece.

Methodology

The analysis is divided in two successive parts related to the postgraduate education and the effects of enterprise characteristics on employment respectively. As mentioned above the presentation of the PPs and specializations is based on quantitative analysis of all relevant data collected through direct contact with all University departments offering postgraduate studies in the ICT sector (Kostoglou 2004b).

The investigation of the postgraduates' employment main issues is the result of a recent national survey addressed though post and electronic mail to all 1134 active ICT enterprises residing in Greece (Kostoglou and Paparrizos 2004d). As research tool was selected a

structured questionnaire. It has been designed according to internationally accepted techniques taking into account that several of the questions were asking for informants' opinions and estimations towards employment (Fowler 1995). Survey's main priorities have been the answers' credibility and the response rate maximization. For the latter objective effective techniques were applied such as the co-operation with the two national federations of IT enterprises which supported survey's conduct, the prenotification of the potential respondents, the adoption of a strict privacy policy, the provision of four alternative ways for returning the filled questionnaires and the forwarding of two reminders to initial nonrespondents (Jolson 1977, Schegelmilch and Diamantopoulos 1991). The number of collected valid questionnaires came up to 343, corresponding to a response rate of 30.2% which is considered as satisfactory and adequate for gathering reliable results (Linsky 1975).

Regarding questionnaire's structure three main research axes were identified for the thorough examination of postgraduates' employment. The first one, including 5 'closed' questions, deals with the recording of enterprises' main profile characteristics. Two principal 'multiple choice' questions investigate the employment of all educational levels' ICT graduates in the labour market and the enterprises' order of preferences for the employment of postgraduates respectively. Four questions, covering the third research axe, include labour market's estimations towards the specialization through postgraduate studies examining issues such as the need, the extent and the demand for specialized ICT employees as well as the capabilities for finding such personnel.

Results

The data derived were coded and analyzed with the use of SPSS v. 12.0, the statistical package for the social sciences (SPSS 2003). For the investigation of the existing effects on

employment policies as independent variables are considered five characteristics outlining the enterprises' profile: the location, the age (year of foundation), the size (number of full-time employees), the geographical range of activities and their main vocational directions. Dependent variables are the parameters describing the labour market's policies and estimations for the ICT postgraduates' employment.

Analytical statistical techniques have been applied for the investigation of the association between the dependent and independent variables. The main statistical tests implemented are the X^2 test and the analysis of variance (ANOVA). Additionally all corresponding Spearman correlation coefficients have been calculated for the detection of any existing trends (McCall 1990). Major results are presented in the next four subsections.

The enterprise characteristics

The analysis of the characteristics outlining the ICT enterprise profile is presented in table 2. Regarding the location, more than half of the companies are based in the area of Athens. There is also a high concentration in Thessaloniki (27.1%), whilst a relatively small minority resides in the rest of the country (17.8%). The decade of 1990's has been very productive in the foundation of new ICT enterprises (51.1%); nevertheless more than a third of their present total operate for more than 15 years, a clear indication of sector's dynamics. The vast majority of companies employ up to 50 persons (82.7%). However the operation of more than one hundred large ICT enterprises gives a sign for prospects of further development.

-Insert Table 2 here-

The analysis of the geographical range of the companies' activities reveals the existence of strong competition and satiation in the local market, as three out of four companies activate at national or international level. It has also been found out that the ICT enterprises

are concerned with seven main vocational directions. Multi-occupation has been noted as the total mean approaches four (3.7) vocational directions per company.

The employment and preference policies

Enterprise representatives provided information about the employment of ICT graduates of all educational levels at their company. The corresponding results are presented in table 3. Without doubt University and TEI graduates enjoy - due also to their large numbers - the highest spread in the sector's market, staffing more than 75% of the enterprises. It is nevertheless clear that taking into account the much smaller number of postgraduates their dissemination in the ICT enterprises is relatively very high (42.7%), overtaking this of the lower educational levels.

-Insert Table 3 here-

The enterprise preferences for the employment of ICT postgraduates have been analyzed through the measurement of the hierarchy set when seeking for new specialized workforce. The corresponding results displayed in table 4 prove the high preference for MSc or PhD holders. They are the first choice for employment of nearly half of the companies and the second or third of the vast majority of the others. Higher preferences enjoy only the University graduates being the first preference of 52.3% of the employers and the second of 42.1% of them, the main explained reason being the significantly lower offered salaries.

-Insert Table 4 here-

Labour market's estimations

The estimations of the enterprises' executives about issues related to the employment prospects of the ICT personnel were investigated through several appropriate questions. The topics examined here are the forthcoming need and demand for postgraduate specializations,

the expected alterations in the specialization extent and the capability for finding such personnel for employment.

Need for postgraduate specialization

Labour market's representatives almost unanimously believe (87.7%, against only 3.7% who have the opposite opinion) that the need for postgraduate specialization is today higher in comparison with the recent past (1999). Only 8.6% of the respondents consider that this need has remained unaltered.

Demand for specialized personnel

The majority of the respondents (74.8%) express their certainty for the imminent increase of the demand for specialized through postgraduate studies ICT personnel. Stable demand forecasts the 16.7% of the enterprise representatives and lowering only the 8.5%.

Extent of specialization

The labour market expects that the forthcoming increase of the demand as well as of the number of ICT postgraduates will result to more specialization. This is concluded from the nearly identical opinions: 78.2% of the respondents anticipate more extended specialization, whereas 17.4% expect stability and just 4.4% decrease.

Capability of finding specialized personnel

ICT companies ascertain the need for specialization of their employees, acknowledging at the same time their relevant efforts as well as those of the educational system. Pessimism for the capability of finding such personnel for employment expresses only 14.8% of the enterprise representatives. Modest prospects estimate almost half of the informants (48.6%), whilst optimistic declare more than a third of them (36.8%).

The effects of enterprise characteristics on employment

The investigation of the impacts of enterprises profile on their employment policies and estimations constitutes one of this paper's principal aims. Appropriate statistical tests have been implemented in order to reveal the existing associations and trends. In the following paragraphs all main results derived from statistical analysis are presented and commented.

The effects on employment policies

Table 5 illustrates the statistically significant results yielded by the application of the X^2 test (significance level 95%). These results lead to a clear indication that the enterprise size, the geographical range of activities and the occupation with four of their main vocational directions differentiate their policies towards postgraduates' employment. These findings are confirmed by the corresponding Spearman correlation coefficients (p_s).

-Insert Table 5 here-

The conclusions derived by the implementation of both tests are the following:

- Larger and internationally activating companies employ more postgraduates than the smaller and locally operating ones (p_s = 0.383 and 0.239 respectively).
- ICT companies located in Athens (p_s = -0.124) tend to employ more postgraduates than the ones located in the rest of the country.
- Enterprises dealing with "Information systems development", "Education and further training" or "Research" need the employment of more personnel holding postgraduate degrees, whereas those dealing with "Sales, provisions and market research" prefer to employ graduates with lower degrees (p_s = 0.189, 0.237, 0.394 and -0.164 respectively).
- The number of vocational directions of an ICT company affects positively the employment of postgraduates (p_s = 0.119).
- The enterprise employment policies are statistically independent of their age.

The effects on preferences for employment

For the detection of the existing correlations the analysis of variance has been selected as the most suitable for the case statistical test. Moreover the Spearman correlation coefficients were calculated for all possible combinations. The spare statistically significant results presented in table 6 prove the low impact of enterprise profile on their preferences for the employment of ICT specialists holding a postgraduate degree. Both statistical tests verify statistically significant effects by only two variables; the enterprise geographical range of activities (positive effect) and their vocational direction "Sales, provisions and market research" (negative). A negative trend towards preference for postgraduates for enterprises dealing with "Technical support" seems also to exist. All other independent variables do not affect enterprise preference policies.

-Insert Table 6 here-

The effects on labour market's estimations

The implementation of all appropriate statistical techniques proves the nearly uniform enterprise estimations about the examined issues related to postgraduates' employment. The impact of their profile characteristics is small; the sole detected exceptions being the following:

a) Estimated demand for ICT postgraduates

Large ICT companies estimate with more certainty that the demand of specialized personnel is to go up (from X^2 analysis: $X^2 = 21.732$ - $p = 0.017$, Spearman's coefficient: $p_s = 0.125$).

b) Estimated capabilities for finding specialized personnel

Larger, centrally located (situated in the area of Athens) and activating at international or national level companies expect better relevant prospects (corresponding statistical findings for the location are: $X^2 = 11.642$ - $p = 0.020$, F(ANOVA) = 5.929 - $p = 0.003$, $p_s = -0.131$, for

the size: $X^2 = 23.820$ - $p = 0.008$, F(ANOVA) = 4.501 - $p = 0.001$ and $p_s = 0.237$ showing the existence of a strong trend and for the activities' geographical range: $X^2 = 17.794$ - $p = 0.007$ and $p_s = 0.109$).

Conclusions

This paper examined some of the relationships between the postgraduate education provided in the ICT sector and the relevant labour market. The research focused on the policies adopted for the employment of specialized personnel and on the effects of enterprise characteristics on their practices and estimations.

Regarding the provided postgraduate education in Greece, its recent impressive evolution was analyzed and the reasons for the development of new PPs have been identified; one of the principals being the European Union's financing. A large variety of 51 different postgraduate specializations is presently offered, being divided in five main categories. The relatively poor geographical allocation of the provided PPs and, more importantly, the small number of the postgraduate students despite the high demand from both ends; undergraduates and labour market; should be in the centre of the educational policy of the state.

ICT postgraduates are largely spread in the labour market being employed by more than 40% of the sector's enterprises. They are also highly preferred by the employers being the first preference of nearly half of them.

Employers' opinions and estimations for the professional prospects of ICT postgraduates are positive. The vast majority of enterprise representatives forecast increased needs and demand for specialized personnel. Furthermore the necessity of finding such personnel for employment will lead to deeper specialization. Labour market's relevant estimations as well as ICT postgraduates' wide spreading in the enterprises constitute strong indications of their

present and anticipated high employability. This is also a reflection to the quality of their studies and the adequacy of the acquired knowledge and skills.

The investigation of the impacts of enterprise profile on postgraduates' employment issues lead to interesting findings. Certain profile characteristics affect significantly their policies towards employment of ICT postgraduates. They are employed more by large, central and internationally activating companies, as well as by those dealing with information systems development, education and research. ICT companies having at least one of the first three above characteristics are more optimistic for the expected rise of the demand for highly specialized professionals and for the prospects of employing them. In contrary, the enterprise preference policies for their employment are nearly uniform.

The recent impressive development of the ICT postgraduate studies in Greece denotes the effort of the higher education to conform to labour market's needs and demands. However the expected high employability of specialized personnel requires the continuation and further intensiveness of such efforts. On the other hand the emerged brilliant professional prospects of the ICT postgraduates should direct them mostly to large and central ICT private companies.

Regarding the further development and extension of this paper's results two feasible axes of future work have been identified. The first one is related to a more detailed and accurate analysis of the outputs of the ICT postgraduate education in the Greek labour market. This will be achieved by an already ongoing research work - in cooperation with the Hellenic Naric (Greek National Academic Recognition and Information Center) - consisting of the collection and analysis of data related to the numbers of students going abroad for postgraduate studies. The second proposed work is related to the internationalization of the aforementioned topics' investigation. An analogous research work in a number of countries,

having also a comparative character, would surely have a more generic framework and attract a much broader audience.

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Table 1. Categories and numbers of taught postgraduate subjects

	Subject categories	Total no. of subjects	Mean no. of subjects
1	Sciences[1]	17	0.7
2	Systems Operation and Architecture	27	1.4
3	Software Technology	20	0.9
4	Hardware Technology	33	1.4
5	Theoretical Computer Science	15	0.6
6	Data Organization and Analysis	14	0.8
7	Information Systems	12	0.4
8	Networks and Communications	31	1.2
9	Multimedia and Internet	19	0.9
10	Automatic Control - Robotics - Systems of Knowledge	43	2.4
11	Reliability - Security - Quality	18	0.7
12	Special Applications of Information Technology	11	0.4
13	Management, Economics & Law	22	0.5
14	Information Technology and Society	4	0.1
15	Information Technology and Education	6	0.2
16	Others	9	0.3

[1] denotes subjects related to pure and applied Mathematics, Physics etc.

Table 2. ICT enterprises' profile characteristics

Location	(%)[1]
Prefecture of Athens	55.1
Thessaloniki	27.1
Rest of Greece	17.8
Age (year of foundation)	
After 1999	12.3
Between 1995 and 1999	29.5
Between 1990 and 1994	21.6
Before 1990	36.6
Size (number of employees)	
1 – 10	40.2
11 – 20	22.7
21 – 50	19.8
51 – 100	7.6
101 – 250	5.9
More than 250	3.8
Geographical range of activities	
Local	8.5
Regional	16.6
National	41.7
International	33.2
Vocational directions	
Service delivery	75.8
Technical support	64.7
Information systems support and maintenance	61.5
Information systems development	59.8
Sales, provisions and market research	57.4
Education and further training	25.4
Research	23.0

[1]: percentage of ICT enterprises

Table 3. Graduates' employment in enterprises

Educational institution / degree	%[1]
Postgraduates (MSc or PhD degree)	42.9
Universities	76.4
Technological educational institutes (TEI)	76.7
Institutes of vocational training (IVT)	47.8
Private colleges of further education	28.0
Secondary education	33.5

[1]: percentage of ICT enterprises

Table 4. Enterprise preferences for postgraduates' employment

Preference for ICT postgraduates	%[1]
First preference	47.8
Second preference	20.8
Third preference	22.4
Fourth preference	4.5
Fifth preference	4.5

[1]: percentage of ICT enterprises

Table 5. The impacts of enterprise characteristics on employment policies

Independent variable	X^2	p
Size	51.090	0.000
Geographical range of activities	19.965	0.000
Information systems development	20.087	0.000
Sales, provisions and market research	5.296	0.021
Education and further training	4.775	0.029
Research	15.399	0.000

p: significance level (X^2 test)

Table 6. The impact of enterprise characteristics on preferences for employment

	ANOVA Test		Spearman's coefficient
Independent variable	F	p	p_s
Geographical range of activities	3.26	0.024	0.246**
Technical support	0.89	0.347	-0.157*
Sales, provisions and market research	8.30	0.005	-0.216**

p: significance level (ANOVA test) - *: $p<0.05$ - **: $p<0.01$

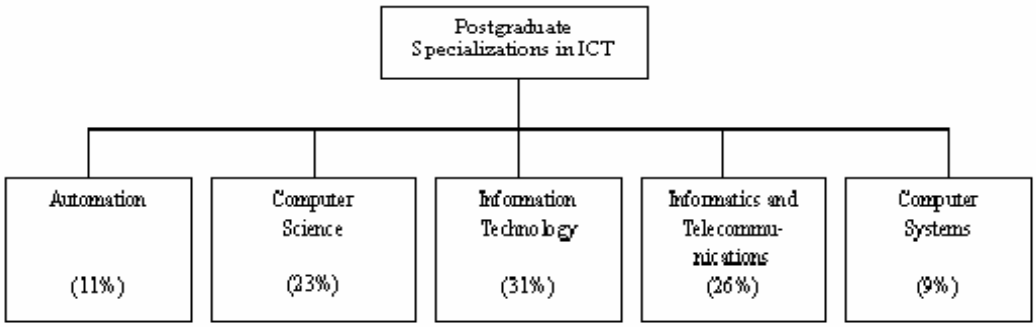

Figure 1: Categories of provided postgraduate specializations

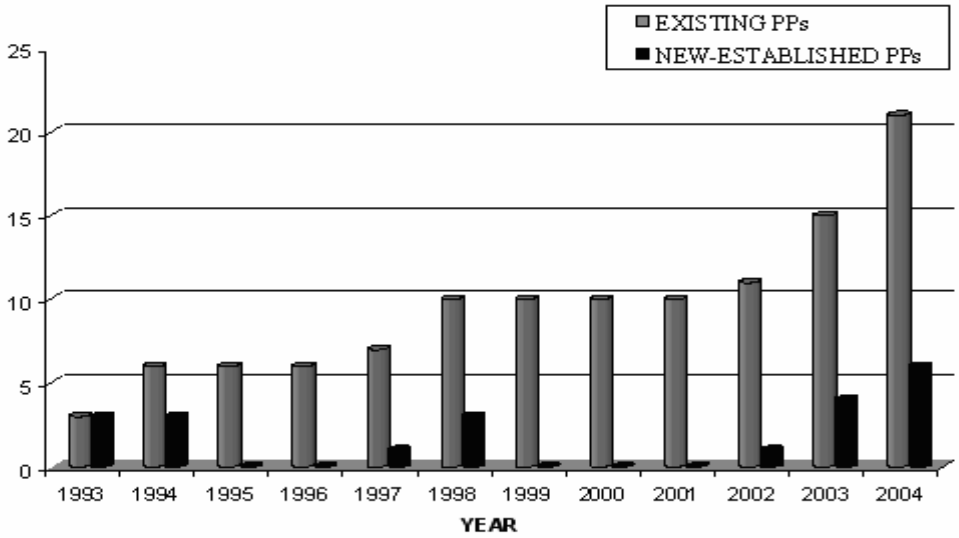

Figure 2: The evolution of ICT postgraduate programmes in Greece