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Towards a longitudinal survey design for PhD evaluation

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Summary: The general lack of homogeneous micro data on PhD system at national level in Italy prevents a continuous and harmonic evaluation and updating the educational process. In this paper, a new design for the national survey of PhD training is discussed. The proposed survey design aims at providing useful information in order to improve the understanding of the supply and demand of researchers across all sectors and disciplines so that educational and research policies can be better targeted.

Keywords: Evaluation, PhD careers, PhD outcome, longitudinal survey.

1. Introduction

Economists admit that the accumulation of human capital and economic knowledge plays a key role in long term economic growth. The stock of skills and knowledge is a standard input of production on which the output growth rate depends and it represents a primary source of technologic innovation (Romer, 1986; Aghion and Howitt, 1992). In particular, public investment in higher education of "excellence" (Doctorate of "Philosophy"- PhD or master's degree) means increasing

the supply of highly-trained workers who have to produce new scientific knowledge. This is very useful in periods of significant technologic changes, when human capital in the working force has to rapidly get up to date to counterbalance the obsolescence of the developed skills in the old technologies through the increase of the supply for new skills. In this context, the analysis of the labour market performance of this particular sub-population of workers, is advisable in order to evaluate if the higher level of public investment both in terms of time and of resources has real confirmation in the labour market.

In particular, we concentrate our attention on the PhD population. In Italy, the PhD was established in 1980 (D.P.R. 382/80) as the highest level of education in the academic system, the current regulation (art. 4, L.210/98) states "*I corsi per il conseguimento del Dottorato di Ricerca forniscono le competenze necessarie per esercitare, presso università, enti pubblici o soggetti privati, attività di ricerca di alta qualificazione*".

Actually, the Italian society has never paid too much attention to the Doctoral system, that is often seen as a mere prolongation of higher studies or training for an academic career. Looking at the occupational situation and at the recent trend of recruitment of researchers in Italian universities it is possible to observe at least the following: i) employment outlets are insufficient in comparison with the number of PhD graduates; ii) the weak investments in Research and Development (R&D), above all in the South of Italy; iii) the percentage of researchers in the labour force is the lowest in Europe. These consideration should stimulate a meaningful discussion on the above mentioned issues. In order to think in terms of matching demand and highly qualified labour supply, it is not enough to know the number of enrolled and graduated PhDs and data on the their planned recruitments, but it is also necessary to evaluate PhD training and outcomes in order to support the long term economic development and competitiveness between people, skills and research outlets, as stated in the Lisbon Agenda of 2000.

The lack of care and attention given to the PhD system in Italy, is also reflected in the lack of systematic information on that system. Unfortunately, in Italy it is very difficult to have a homogeneous and clear picture on the labour market outcomes of PhDs and on PhD

training since the experience of data collection on that topic looks too irregular and heterogeneous.

For better understanding of such a picture we have to think in terms of a national survey that should at least answer the following important questions: i) what are the differences between PhD candidates/winners/graduates; ii) what the PhD training in Italy really offers; iii) what is the external effectiveness of the doctorate.

In this way we want to understand if there is a mismatch among the purpose of doctoral education, the aspirations and the realities of their careers within and outside academia (Golde and Dore, 2001) and we aim to have a systematic analysis of career development and impact in order to allow, at least in part, the control of a suitable dimension of the supply and to give useful information to the higher education system in order to prevent problems of overeducation that can be very relevant for PhD graduates (Nerad and Cerny, 1999; D'Agostino and Ghellini, 2008).

Recently, some efforts in that direction have been carried out, trying to create a more homogeneous information system at national level, at least on some of the above mentioned questions. We particularly refer to two initiatives. One is the pilot survey conducted in 2005 by the Italian national statistical institute (ISTAT) to respond to the request of information on PhD working careers formulated by OECD in the framework of the CDH (Careers of Doctorate Holders) Project (the first survey for Italy is foreseen at the end of 2009–beginning of 2010); the other is promoted by the Italian CNVSU (Comitato Nazionale per la Valutazione del Sistema Universitario). Both are going to collect names and addresses of Ph. Doctors from all the Italian universities for three different cohorts, with the aim of undertaking a national retrospective survey on their occupational situation.

Starting from this perspective, in this paper we aim to outline the subjects and the modalities of an overall design for a national PhD survey. The issue will be developed with strong reference to other experiences and mainly to the retrospective survey carried out in 2007 by the University of Siena on four cohorts of PhD graduates.

In brief, the paper is organized as follows. We first introduce the reference background taking into account what we actually know about

PhDs in Italy and we briefly present the PhD survey conducted in Siena (section 2). Then, considering what we would need to know about PhDs in Italy, we describe the outlines of a national survey proposal (section 3). Finally, some concluding remarks end the paper (section 4).

2. Reference background

2.1. The PhD in Italy: what we know

In Italy, a PhD is the highest degree awarded by a graduate school, usually to a person who has completed at least three years of graduate study and a dissertation approved of by a board of professors[1]. Many drawbacks affect this maximal level of education: the financial support to the research in Italy is below the average in Europe (ISTAT, 2006, 2007), about 1.1% GDP; the economic evaluation of the PhD title does not exist and generally the private sector does not find any recognition of the title, consequentially the usual outcome for PhD graduates is an academic career or public research institutions; among the member states of the European Union, Italy has been recognized as the country having the worst conditions for young scientists and for this reason many excellent young people leave the country in order to study or work abroad; the "brain drain" is usually not compensated with incoming foreign students since nobody wants to come to study or to work to a country with these poor conditions.

If, in the past, the academia was the natural placement for PhD graduates, the recent official trends data (CNVSU and MIUR -Ministero dell'Università e della Ricerca-) show worrying trends between academic outlets and the number of PhD graduates (see Table 1).

In fact in Table 1 we can observe that, despite the fact that the number of PhDs awarded increased by 142% from 2002 to 2006, the number of new academic research positions decreased by 25%. Such a trend shows that the academic outlets become increasingly less capable

[1] In Italy, most doctoral programs last 3 years – but few, like Mathematics, last 4 years. Extensions are granted in special cases to finish one's own research, or in the case of maternity or serious illness.

of absorbing PhD graduates (from 0.52 in 2002 to 0.16 in 2006), with a very strong cumulative effect in the long run. In that perspective, the extent of public resources designed to R&D, the organizational and financial structure of the academic market and the recruitment politics of the university and research institutions have to play a determinant role in researcher demand and supply.

Table 1. Academic research positions and number of PhD graduates

Year	New Academic research position (A)	Number of PhDs (B)	A/B (%)
2002	2139	4139	0.52
2003	1271	6249	0.20
2004	2303	8346	0.28
2005	3066	9477	0.32
2006	1625	10057	0.16

Source: CNVSU and www.statistica.miur.it

For example, in 2007 (see Table 2) the firms demand was high for second level university degrees whilst it was very low for higher level education (and PhDs represent only a part of it). Thus the private sector seems to be able to play only a marginal role in recruiting PhDs, and in any case it is not sufficient to cover the "overproduction" of PhD graduates.

Table 2. Firms recruitment demand by activity sector and type of degree (2007)

Activity sector	Overall Total (a.v.)	With University degree (a.v.)	II level degree (5 years) %	
			total	which with post-degree
Industry	329140	19250	56.7	5.2
Construction	122930	1470	58.4	4.8
Services	510320	56080	45.4	7.1

Source: Unioncamere-Ministero del Lavoro, Sistema informativo Excelsior, 2007

Other information on PhDs can be derived from local surveys. Most of them concern a single university as, for example, the University of Pavia which carried out a web survey in 2007 on three PhD cohorts-graduates between 2004 and 2006 - on the assessment of PhD training and on work conditions after the PhD, or the University of Milano Bicocca and Trento that made a telephone survey in 2006 on three PhD cohorts - XII up to XVI - on occupation outlets after the PhD, or the PhD survey conducted by the University of Siena in 2007 the data of which we refer to in this paper.

Other experiences are based, on the other hand, on more than a single university and are generally conducted by an external authority. For example, the Associazione Dottorati Italiani (ADI) carried out a web survey on PhD graduates in 37 Italian universities but with a very low response rate or the Stella Project that conducted a web survey in 2009 on PhD graduates (from 2005 to 2007) on which preliminary results have been presented at the Workshop *Il Dottore di Ricerca: un motore di innovazione per le imprese?* (Milano, July 2009) or the retrospective survey on labour market outputs of young people that have participated in higher education courses (PhD or master's degree) in 1999-2004, co-financed by Fondo Sociale Europeo (FSE) in southern regions (ISFOL, 2007).

Despite the large variety of experiences not comparable in terms of aims, approaches, collecting methods, questionnaires, reference times, etc., some common findings persist, such as: the employment rate, 12 months after the PhD degree, is about 80%; almost 50% is recruited by academia, more than 50% have a non permanent position in the current job (many postdoctoral researchers indeed are employed on short-term contracts tied to a particular funding stream and/or research project), the salary is low with respect to the high level of education achieved.

2.2 The Siena experience

As we mentioned before, the survey conducted in Spring 2007 by the University of Siena can be considered a macro pilot survey on the PhD

graduates providing food for thought and interesting suggestions for a national PhD survey.

The main aim of that survey was to collect data on educational and professional careers along with information about PhD satisfaction and present job satisfaction. It was designed as a census survey on four cohorts (XV up to XVIII) that have achieved the degree between 2003 and 2006. The large amount of information collected with such a survey (socio-economic background, evaluation of Phd. training experience, work history, assessment on job activity, etc.) allows different interesting themes concerning doctorate holders to be discussed (for more details on empirical results see D'Agostino and Ghellini, 2008; Ghellini, 2009). In this paper we present just some results useful for suggestions for the proposal of a new national survey.

With regard to the data collection, it is necessary to underline that it was a cross-sectional retrospective web survey with a preliminary personal e-mail sent to each person. The composition of the population by gender and cohort is described in Table 3.

Table 3. Distribution of reference population by gender and cohort (a.v.)

	Cohort				
Gender	XV	XVI	XVII	XVIII	Total
Male	69	85	94	73	321
Female	90	110	123	82	405
Total	159	195	217	155	726

With regard to the response rate (see Table 4), the results are actually satisfying, in fact the total response rate is 77.8% (without considering the non contact phenomenon). There are no differences by gender, while RR is inversely related to the age of the cohort: it is less than 70% for the oldest cohort and achieves the value of 86.5% for the most recent one. This phenomenon is reasonable and encouraging: reasonable because there are many examples in literature showing that the response rate in retrospective survey is inversely related to the length of the time span (a similar result is also obtained in the PhD survey conducted by the University of Pavia); encouraging because we think that this effect could be mitigated with a longitudinal survey based on "good" tracking rules and on "good" rules for the panel maintenance.

Table 4. Total Response Rate (RR) by gender and cohort

RR	Cohort				
Gender	XV	XVI	XVII	XVIII	Total
Male	71.0	77.7	77.7	83.6	77.6
Female	68.9	78.2	77.2	89.0	78.0
Total	69.8	77.9	77.4	86.5	77.8

With regard to the survey design, the Siena experience provides some useful issues on the use of web methodology. The RR indicator in Table 4 is indeed the overall response rate, however given the different form of reminders used (e-mail, phone, letters) we defined different response rates based on different reference subpopulations. In our context the Web Response Rate *(WRR)* is particularly important; it is defined as:

$$WRR = 100 \times \frac{WR}{M} \tag{1}$$

where M is the estimation of the population reached by e-mail and WR is the set of respondents of such A population. In short, the WRR can be roughly considered as a final response rate if a revised database with updated e-mail addresses really exists.

The WRR indicator (see Table 5) clearly shows higher response rates than the RR indicator for all the subset considered. Given this evidence, a continuous updating of a contact archive, a very easy practice and common in panel surveys, seems to be extremely useful for further increasing the response rate.

Table 5. Web Response Rate (WRR) by cohort

	gender		cohort				total
	M	F	XV	XVI	XVII	XVIII	
WRR	87.8	88.4	81.3	88.0	89.2	93.6	88.1

Aiming at planning a new survey design in a longitudinal perspective, could also be interesting for analysing the relationship between working conditions and satisfaction of the PhD training experience arising from the Siena survey (see Table 6). The satisfaction on different items related to the training experience seems to be biased by the working condition experimented. For example, PhD graduates with a *permanent research position* are in general the most satisfied for all the considered items. On the other hand the unemployed are the least satisfied with respect to the "organization" of the training process and the "utility". of their qualification, while, in the meantime, they are very satisfied as far as "learning" is concerned.

Table 6. Agreement with some sentences concerning PhD experience by working conditions – values of the index IS [0-1][2]

	satisfaction for training organization	satisfaction for learning	PhD useful for qualification
All respondents	0.495	0.628	0.357
Research fellow	0.518	0.356	0.679
Permanent research	0.642	0.683	0.604
Permanent no research	0.506	0.587	0.409
Self employed	0.495	0.584	0.396
Not working	0.411	0.630	0.216

Another lesson that can be learnt from the Siena experience regards the timing of data collection on labour market entrance after the PhD. In the Siena survey the median time to obtain the first job is about 5 months (this finding is also confirmed by the other local experiences

[2] This index has been proposed by Capursi, Porcu (2001) and Capursi, Librizzi (2008) in order to evaluate the educational aspects. The index formula computes the distance between the observed distribution of each item and its expected distribution in case of maximum scores. There is a proximity to the ideal situation (in which all respondents are totally satisfied) the more IS_r approaches the value of 1.

mentioned above). Moreover, from Table 7, we can observe that about 90% of the graduates have a waiting time for the first job which is less than 12 months, with no significant differences by gender.

Furthermore, for the first working episode, the average duration was about 15 months and only 10% of PhD graduates have more than two working episodes.

Looking at these results, it seems to be reasonable to plan the first wave of the follow-up at 12 months after the PhD thesis, in order to pick up the beginning of the career pattern. Moreover, these figures suggest establishing the second wave of follow-up at 24 months, considering that after this time span the majority of individuals are practically in a stable condition.

Table 7 . Waiting time for the first occupation by gender (column %)

	Cohort				
Male	XV	XVI	XVII	XVIII	Total
Already employed before of the PhD	64.88	53.95	37.68	38.84	48.16
One month	4.73	15.52	13.09	16.33	12.67
2-6 months	8.15	23.01	21.05	15.66	17.61
7-12 months	8.61	7.52	18.45	11.58	11.86
More than 12 months	13.64	0	9.73	17.59	9.69
Female					
Already employed before of the PhD	32.85	39.82	50.37	37.59	41.07
One month	12.65	10.07	8.54	7.49	9.65
2-6 months	30.04	20.09	24.19	29.53	25.43
7-12 months	14.48	14.73	8.84	14.76	12.88
More than 12 months	9.98	15.29	8.06	10.63	10.97

3. A longitudinal survey design proposal

3.1. PhD in Italy: what we need to know

In the previous section we underline the existence of a gap between the demand and supply of highly qualified workers. We also mentioned that a PhD is essentially the first step to an academic career whereas the demand from enterprises is actually very poor. This disequilibria in the

labour market also creates the potential problem of over-education (Chevalier, 2003; Chevalier and Lindley, 2009). In this perspective the issue of making use of the PhD degree outside the academic system is currently more and more important in order to pursue the objective of supporting innovation and competitiveness of enterprises, especially in the South of Italy, through the training of highly qualified human capital. This issue is also correlated to other more general themes, such as: the ability of the PhD system to discriminate at the beginning of the training period, the cognitive ability and personal motivations; the connection between university and enterprise through a transfer of knowledge; the supporting policies to encourage R&D through the qualification of human capital capable of performing these activities; the ability of the enterprise to enrol highly qualified workers in the R&D sector and to recognise the financial value of the PhD taking personal ability into account.

To overcome the informative gaps on the PhD system, we need to know more about this system. In order to make what we need to know clearer, it is worth making a theoretical distinction between the PhD as a process and the PhD as a product. Considering the PhD as a process, we need to have detailed information on motivations for undertaking a PhD, initial career aspirations and final evaluation of training experiences. In this way, we can understand if students, while they are choosing to apply for a PhD course, have clear reasons, motivations and perspectives for doing so and, in the end, if they are satisfied with the decision to pursue the PhD. Moreover we need to evaluate the structure and organization of the different PhDs in order to harmonize PhD programs across different universities, to clearly define the role of the PhD in the university system and to define the optimal type of training for the outcomes. In short, this information allows us to obtain a more systematic and structured doctoral education programme that allows higher level of transparency regarding admission, selection and quality assessment.

With regard to the PhD as a product, detailed information is needed on skills development, training and job satisfaction ; employment history; current employment characteristics as well as future career aspirations.

This information may be useful for different purposes, such as for estimating the impact of the PhD degree in the labour market and determining what factors positively promote or prevent the successful development of such pathways. In this way we can have a clear concept of the suitability for work outside an academic career, and know if the transition of doctorate holders to employment have consequences on their personal life-planning.

3.2. Main issues of the survey design

As mentioned in the previous section, it would be necessary to collect a wide set of information in order to study the PhD either as a process or as a product.

To address these issues, it would be necessary to consider a comprehensive longitudinal survey design covering the whole population of a PhDs cohort (or it will be explained below, covering all the applicants for a PhD training).

Before describing the complex timing schedule of the proposal, it is worth explaining why we prefer a cohort survey with a longitudinal approach to a cross-sectional retrospective survey covering doctorate holders from different cohorts. It is well known that in retrospective survey the quality of data can be heavily affected by the memory effect; moreover in surveys on the same population it has been demonstrated that the response rate is inversely related to the age of the cohort (Ghellini, 2009; Campostrini, 2008). Such an effect could be mitigated keeping in continuous touch with the statistical units.

To define the collecting time two complex phases could be considered: collection of data "Before the PhD degree" and collection of data "After the PhD degree". These two phases cover the above mentioned domains i.e. the PhD as a process and the PhD as a product.

Starting with the collection of data before the PhD degree, the scheme can be summarized as follows:

- Before entering into the system
- During the training
- At the end of the training

Let us consider the reasons for the collecting time introduced and then how, in practice, the collection could be conducted. Keeping these reasons in mind as well as the fact that we would like to evaluate the PhD as a process it seems reasonable to collect information to evaluate the whole training process on:

- intellectual growth, critical thinking, and understanding of the subject;
- support for scholarship;
- freedom of inquiry;
- capacity to make links across disciplines;
- links with other scholars in the field, assistance with conference participation;
- access to the literature;
- encouragement to produce outputs, papers etc;
- development of professional skills;
- training needs.

Moreover, it could be very interesting to have information on motivations and initial career aspirations (it would be useful to benchmark the initial rationale for undertaking a PhD with subsequent career development), and also on current attractive and disincentives of the PhD training. For example, the Council for Industry and Higher Education (2001) recommended the improvement of PhD salary levels to ensure that the UK's supply of scientists and engineers is maintained. The divergence between PhD salary levels and graduate salaries, and the effect of growing undergraduate debt, are acting as disincentives to postgraduate study. However, this should to some extent be offset by the good long-term salary prospects of postgraduates.

With regard to the collection methods, the following scheme could be designed.

- Before entering into the system, data could be collected by an application form that all the candidates must compile. The layout of the application form should be common, at least for a core part, for all the universities; in this way a National PhD Applicants Archive could be built up with very limited costs. The basic information to collect at this step should be: background information, motivations, contact addresses (telephone number, e-mail, etc.).

- During the training, data could be collected by mail/web questionnaire, particularly, during the first year, asking initial career aspirations and, in subsequent years, evaluation of organization, training, teaching supply, tutors, international network etc..
- At the end of the training, data could again BE collected by mail/web questionnaire, for a final evaluation of training, skills development, job expectations, and also for collecting some information on personal time dependent characteristics, such as marital status, children etc..

In addition it would be very important and not too expensive to develop consistent mechanisms to continuously record the alumni activity (publications, project participation, conference participation, research activity abroad, research award) and the alumni addresses (postal address, e-mail addresses, telephone numbers) for the panel maintenance. This information should be linked to the National PhD Applicants Archive.

The opportunity for collecting information on the evaluation of different aspects of the PhD process, during the training, and not only ex-post, is very important, in fact, it is well known that in general the current situation could influence the judgement on past events. This phenomenon has been found in the analysis conducted on the data collected by the PhD Siena survey (see Section 2.2 above).

Now, let us consider the collection process "After the PhD Degree". In this phase, the collection of proper information makes it possible to evaluate the PhD as an output, considering its effectiveness in terms of

- impact on career: data on the employment history of the individual should be collected to pick up the impact of the PhD degree on the career. Furthermore, it would be useful to have information on the employment history of a group of PhD applicants who have not obtained the degree (a sort of control group);
- monetary and non monetary job satisfaction: data on current employment characteristics, utility of the skills, research activity and obviously satisfaction for different features of the current job;

- future career aspirations.The above mentioned information could be collected at different stages of the post PhD career by a sort of follow-up of the individuals using a mail/web survey. Similar surveys on school to work entrance, are used to collect information on the career JOB referring to 12/24/36 months. For the proposed design on PhD we suggest two follow ups at 12 and 24 months from the degree, as stated in Section 2.2, with the addition of another data collection at 5 years. This last follow-up could be useful in order to assess the situation at long term and also for monitoring the career progression.

At each stage of the follow up, information on relevant changes in family status (marriage, children, etc.) have to be collected for analysing the impact of demographic choices, on work career, in particular for women.

4. Final remarks

In this paper we attempt to provide a review of the "status quo" and the main issues relating to the PhD in Italy, so as to introduce the idea and the methodology of a new national survey on PhD training and outcomes. We stressed that this discussion would become central for higher educational policy makers in order to compensate through active policies, for the gap between the supply and the demand of PhD graduates and to improve the PhD training in order to be able to better respond to the radical changes in which the knowledge society is involved.

In particular, we started the discussion showing that the lack of homogeneous micro data at national level in Italy prevents systematic and harmonic reorganization of the PhD system. Then, also using the findings of a PhD survey conducted at the University of Siena, we have proposed a comprehensive survey design, based on a longitudinal approach. We think that such a design would be able to give a significant added value to the existing heterogeneous data on higher education and labour supply.

We believe in the feasibility of the survey plan described in Section 3 and in the necessity to make every effort to carry it out in order to have an efficient monitoring of the PhD. In other words, the proposed PhD

national survey could help in collecting valuable information in such a crucial area for government, universities and research councils. Moreover, the information on the PhD process and product achieved with such a design could substantially improve the higher educational system of the country, not only facilitating the reduction of the gap between supply and demand but also by stimulating an improvement of PhD training through a renewed consideration of competences and skills which can be valuable in a wider employment range than those actually achieved.

In brief, this paper discussed a number of issues and it proposed an intervention which, if implemented, could improve the supply of high quality researchers in Italy.

The message of this paper is straightforward. Many initiatives are currently either in place or being put in place but they need stitching together and supplemented in order to provide a coherent framework of information, that seems to be essential for formulating innovative policies at all stages of the PhD system.

Note: Thought the paper is the result of the joint work of all the authors G. Ghellini has written section 4., L. Neri sections 1 and 3, A. D'Agostino section 2.

References

Aghion P., Howitt P. (1992), *Endogenuos Growth Theory*, The MIT Press, Cambridge (MA).

Campostrini S. (2008), Dottore, dottore… con quale futuro? Uno studio sul destino occupazionale dei dottori di ricerca e di valutazione dei dottorati dell'Ateneo di Pavia. *DIVAGO Workshop "La Statistica, la Valutazione e l'Università"*. 10 – 12 July 2008, mimeo.

Capursi V., Porcu M. (2001), La didattica universitaria valutata dagli studenti: un indicatore basato su misure di distanza fra distribuzioni di giudizi, *Atti Convegno Intermedio della SIS "Processi e Metodi Statistici di Valutazione"*, 17–20.

Capursi V., Librizzi L. (2008), La qualità della didattica: indicatori semplici o composti?, in: Capursi V., Ghellini G. (eds.) *Dottor DIVAGO: discernere, valutare e governare la nuova Università,* Associazione Italiana di Valutazione, Franco Angeli, Milano, 139–156.

Chevalier A. (2003), Measuring Over Education, *Economica*, 70, 509–531.

Chevalier A., Lindley K.L. (2009), Over-Education and Skills of UK Graduates, *Journal of the Royal Statistics Society, Series A*, 172, 307–337.

Council for Industry and Higher Education (2001), The Funding of Higher Education, December 2001.

D'Agostino A., Ghellini G. (2008), Labour market outcomes for PhDs, DIVAGO Workshop "La Statistica, la Valutazione e l'Università". 10–12 July 2008, mimeo.

Ghellini G. (2009), *Indagine sulle esperienze lavorative dei dottori di ricerca dell'Ateneo di Siena*, La Formazione Universitaria, UnifePress, 121–137.

Golde C.M., Dore, T.M. (2001), *At Cross Purposes: What the experiences of doctoral students reveal about doctoral education* (www.phd-survey.org). Philadelphia, PA: A report prepared for The Pew Charitable Trusts.

ISFOL (2007), *Gli esiti occupazionali dell'alta formazione nel Mezzogiorno*, I libri del Fondo Sociale Europeo, December 2007.

ISTAT (2006), La Ricerca e Sviluppo in Italia 2002–2004. Collana: *Informazioni* n. 2.

ISTAT (2007), La Ricerca e Sviluppo in Italia nel 2005*, Statistiche in breve*, 11 ottobre 2007.

Nerad M., Cerny J. (1999), Postdoctoral patterns, career advancement and problems, *Science,* 285, 1533–1535.

Romer P. (1986), Increasing Return of Long-Run Growth, *Journal of Political Economy*, 94, 1002–37.