

Zeitschrift: Schweizerische Zeitschrift für Soziologie = Revue suisse de sociologie
= Swiss journal of sociology

Herausgeber: Schweizerische Gesellschaft für Soziologie

Band: 36 (2010)

Heft: 2

Artikel: The leaky pipeline in the Swiss university system : identifying gender barriers in postgraduate education and networks using longitudinal data

Autor: Leemann, Regula Julia / Dubach, Philipp / Boes, Stefan

DOI: <https://doi.org/10.5169/seals-814892>

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The Leaky Pipeline in the Swiss University System

Identifying Gender Barriers in Postgraduate Education and Networks Using Longitudinal Data

Regula Julia Leemann*, Philipp Dubach** and Stefan Boes***

1 Introduction

Recent empirical studies provide evidence in favour of an equalization of male and female educational chances on the tertiary level. According to predictions of the Federal Office for Statistics, the proportion of women completing a master's or equivalent degree will peak in 2010 at 52% and will thereafter remain approximately at this level. In comparison to 1978 – the first year in which the Swiss Higher Education Information System (SHIS) collected data about first degrees – the proportion of women among the graduates on the master's level has more than doubled,¹ although the proportion of women and men substantially varies in the different disciplines (Franzen, Hecken and Kopp, 2004).

This paper tackles the question if gender inequalities develop after the completion of a master's degree while starting an academic career – both in a historical perspective as well as in the perspective of the life cycle of the individuals – and which factors determine the academic integration. Can we observe a convergence in gender specific academic career trajectories, or are gender sensitive selection processes postponed to later career steps? The latter effect is metaphorically referred to as the “Leaky Pipeline” in academic careers (European Commission, 2008, 16 ff.).

The initial step in an academic career is determined by the completion of a doctorate, although some subject areas inside the German-speaking university system additionally require a habilitation before entering the stage of senior faculty. For that reason, we investigate in the first part of our analyses – based on records about individual educational career paths of different cohorts of graduates – the gendered structure of the transition from master's degree to doctoral studies, as well as the completion of a habilitation after the doctorate. Do female graduates begin

* University of Applied Sciences Northwestern Switzerland School for Teacher Education, Chair for Educational Sociology.

** Büro für arbeits- und sozialpolitische Studien BASS, Bern.

*** Institute for Quantitative Social Science, Harvard University and Socioeconomic Institute, University of Zurich.

1 Federal Statistical Office: <http://www.bfs.admin.ch/bfs/portal/de/index/themen/15/06/key/ind1.Document.48480.xls> (accessed 30 November, 2009).

a doctoral thesis as often as male graduates and do they finalise it at the same rate as men do? Do we find any gender differences in the completion of a habilitation after the award of a doctorate?

After completion of the doctorate, some graduates leave the academic field and start a qualified job in other business sectors (Engelage and Hadjar, 2008). This dropout is to be expected, since on the one hand, the labour market outside of academia provides attractive positions for doctoral graduates, and on the other hand, the academic career path involves elite recruitment processes, with only a small proportion of candidates being selected for a tenured position as a professor. In the second part of the paper we concentrate on the factors that may explain these gendered dropout rates.

Two questions are leading our analyses. First, do women have more problems than men to stay integrated in the academic field during their postdoc phase? We investigate this question – based on a comprehensive panel dataset – focusing on whether young female researchers are equally well integrated in national and international academic networks. The personal network of academic contacts serves as an indicator for the quality and dimension of academic integration after the doctorate as there are no clear and measurable career steps at the upper levels of the academic ladder in Switzerland (ladder without rungs). Furthermore, research findings point to the fact that publication productivity and achieved academic positions are positively influenced by the quality and dimension of the network (e.g., Leemann, 2002, Prpic, 1996).

Second, we analyse the internal and external factors that influence the integration into the scientific community, with a particular focus on the effects of family situation (birth of children), the integration in the academic field during the doctorate, as well as the support provided by research funding in earlier stages of the career.

2 The "Leaky Pipeline" in academic careers: Theoretical considerations, state of research, and hypotheses

In order to theoretically conceptualise gender inequalities in academia, we refer to the theory of social domination and reproduction by Pierre Bourdieu. Bourdieu investigated the process of social closure and the recruitment of elites inside the academic field (see Bourdieu, 1975, 1990; Bourdieu and Passeron, 1971). In addition, a number of research projects have been carried out in recent years which usefully apply Bourdieu's ideas to the unequal integration of women and men in the academic field (Krais, 2000, 2002; Beaufaÿs, 2003, Engler, 2001).

Bourdieu's theory points to those social practices and processes in the academic field that are a result of symbolic struggles for university power and academic recogni-

tion. The ruling factions in a specific field try to keep up their relational position in the social space and not to lose power by determining the conditions and the criteria of legitimate membership and legitimate hierarchy (Bourdieu, 1984). The relevant process of social closure is mainly guided by the reproduction of the corporate body. In order to be selected in the academic recruitment process as promising young academics, emerging researchers have to represent the social group of established academics or to be dignified to join the group (Bourdieu, 1990).

The following three topics will receive our attention, theoretically and empirically: (a) Reflections on the crucial dimensions to capture and measure the “Leaky Pipeline” – academic titles and academic networks (our dependent variables), (b) Hypotheses concerning the factors that affect these dimensions (our explanatory variables), (c) Considerations on gender inequalities in academic integration (gender dummy variable).

2.1 Academic integration in general

Academic career trajectories are never a one-person enterprise. Hence, the construction of an academic career is a social process that cannot take place “in loneliness and freedom” (Engler, 2001). Only if upcoming researchers are recognized, elected, promoted and integrated in academic networks by established academics can a career be successful (Bourdieu and Passeron, 1971; Leemann and Da Rin, 2010). Being recognised as a legitimate candidate is a prerequisite for entering the academic field and for settling successfully in the university.

Recognition is carried out by different social and symbolic acts. In the context of our study, two issues are relevant: First, gaining access to the required academic titles (doctorate, habilitation) and getting the essential support for the qualification process by professors. Second, receiving the acknowledgment and recognition of professors and senior researchers through their interest to communicate and cooperate with the upcoming researchers and to share their knowledge and social resources with them. The first issue is related to establishing institutionalised cultural capital, the second concerns the access to social and related symbolic capital (Bourdieu, 2004 [1986]).

2.1.1 Academic titles

The *doctorate*² in Switzerland is not a qualification that is accessible to all students who graduate from university with a master’s degree (see Baschung, 2008). Although

² We use the term “doctorate” instead of “PhD”. There is a difference in the significance of the doctorate between the French-speaking and German-speaking universities. In French-speaking Switzerland, the doctorate, or *thèse*, is significant mainly within the university context. It qualifies one for a professorship and a habilitation is not required. The *thèse* is thus comparable to the Anglo-American PhD. By contrast, in German-speaking Switzerland the doctorate is also valued as a certificate in the labour market outside the university and the requirements to get the doctoral graduation are on average lower compared to a PhD. According to the Bologna declarations, the universities in the German-speaking part of Switzerland are now adjusting their

the conditions, possibilities and procedures of doctoral graduation vary considerably between subject areas and universities, in all cases professors appoint their staff autonomously and decide who gets a job in a research project and who can hand in a doctoral thesis at the faculty. There is no obligation to announce junior positions, and the participation in a postgraduate programme largely depends on the probability to be selected by the professors who are responsible for the programme. This freedom in the recruitment and election process and the missing standardisation of the selection procedure can lead to inequalities in doctoral graduation that violate the principle of universalism in science (European Commission, 2006, 2009; Leemann, 2002; Lind and Löther, 2007; BMBF, 2008; GWK, 2008).

The *habilitation* is a degree assigned by the faculty that qualifies the holder to supervise doctoral candidates. It is required in many subject areas in the German part of Switzerland for access to the professorial level and is undertaken after successful completion of the doctorate. It was introduced in the course of the 19th century in the German-speaking universities (Germany, Austria, German-speaking parts of Switzerland) as an additional required qualification and became an important institutional and symbolic hurdle for women and academics with no privileged social background (Wobbe, 1996; Schmeiser, 1994).

Compared to the doctorate, mechanisms of social closure become even more important when it comes to the habilitation. The election of new faculty members by the present representatives (co-optation) requires that the candidates are endowed with a mostly male connoted academic habitus – a claim to leadership, linguistic eloquence, a sovereign bearing and assertiveness – as the profession of researchers has clearly masculine connotations (see Leemann, 2002, 40 ff.). Women are placed in a situation of conflict and disadvantage because of the contradictions between their gendered and professional self-presentation. It is more difficult for them to be perceived as competent and ambitious future researchers. Furthermore female academics in general have less support by faculty members (BMBF, 2008). As a consequence, female academics plan less often than male academics to undergo a habilitation procedure (Berweiger and Keller, 2005).

2.1.2 Academic networks

The notion of “scientific community” points to the importance of academic networks in the academic field and for academic careers. Academic contacts and relationships are a form of social capital that promote and catalyse the development of a career. In contrast to other sociological concepts of social capital which emphasize its social integrative functions, Bourdieu’s theory underlines the unequal distribution of

system and replacing it with the three cycles of higher education qualification (bachelor, master, doctorate).

these resources and their role in the process of (re)production of social inequalities (Schultheis, 2008).³

Bourdieu defines social capital as “the aggregate of the actual or potential resources which are linked to the possession of a durable network of more or less institutionalised relationships of mutual acquaintance and recognition” (Bourdieu, 2004 [1986], 21). In academia, social capital is built up by personal contacts to (prospective) relevant partners in the context of daily work, during qualification periods, while attending congresses, in research cooperation or through periods spent abroad. The variety, amount and power of these relations are action enabling resources which one can refer to in order to build up further academic capital (reputation, credit, power). Therefore, the emerging contacts and relationships are less altruistic than driven by mutual interest.

For Bourdieu, the practices and effects of social capitalizing are constitutive for the academic field and the games and struggles that take place in this field. If academics are not involved in these processes of accumulation and transformation of social capital, they get marginalized. Eventually, they are placed on the edge of the academic field and fall out of the game (Leemann and Da Rin, 2010). With growing competition, social capital can make the small but significant difference between competitors who are endowed with the same titles and performance indicators (Schultheis, 2008, 49).

Regarding the factors that influence the growth of social capital, we can assume the following relations: Building up and maintaining social capital needs time – working time and life time. For this reason we expect that older academics have a larger contact network since they have belonged to the academic field for more years. Its accumulated work gives access to other forms of capital and can be transformed into cultural and economic capital that is relevant for establishing in academia. For this reason, the partners mutually elect each other and try to assess the future benefit. Consequently, the social status of the partner is important for a successful accumulation of capital. In order to assess the value of a partner, a social sense for good investment is necessary, which is linked to the familiarity with the milieu of academia (Bourdieu, 1990, 55). In our analysis we will check if having an academic family background fosters the amount of academic contacts.

Furthermore, social capital has the character of symbolic capital and serves as a means of distinction, since appreciation and recognition are connected with the contacts that academics have to their disposal. In the meantime, international social capital is becoming ever more important. Periods spent abroad, publications in international journals, or research collaborations with foreign institutions serve as a means of distinguishing oneself in the symbolic contest for recognition and self-demarcation (Bourdieu, 1990, 110). As a consequence, we will differentiate between national and international contacts in our analysis.

³ For an overview of different concepts of social capital see Portes (1998).

Having been geographically mobile fosters the amount of academic contacts, especially the contacts to academics abroad. Therefore we expect that academics who graduated with a masters Degree abroad and subsequently moved into the Swiss university system have more international contacts.

Over the years of their career, emerging researchers can accumulate their academic capital by means of social networks above average: "Capital breeds capital" (Bourdieu, 1990, 85), if they are supported by academically powerful mentors right from the beginning of their career (Long, 1978; Long and McGinnis, 1985).⁴ Mentors operate in the background as patrons and gatekeepers, write references, help establish contacts and vouch for the capability of the protégé (Leemann, Boes and Da Rin, 2010). We therefore suggest that academics who are well integrated in the academic field in early stages of their career and who are supported by mentors are able to build up and maintain a large network of contacts.

Approved research funding leads to academic recognition and credibility, and in consequence enhances the attractiveness as a network partner. Funded research and periods spent abroad using funded fellowships allow for building up domestic contacts and contacts abroad (Lee, 2004; Lee and Bozeman, 2005; Hinz, Findeisen and Auspurg, 2008, 73 f.).

2.2 Integration of female academics in particular

Until recently, the symbolic struggles for the preservation and amelioration of class positions in academia have taken place predominantly among men. Only in the last fifteen years has the proportion of women with a professorship risen significantly from 6% in 1995 to around 15% in 2008.⁵ Despite this fact, we conjecture that female academics still face more problems than men in establishing an academic career because the fraction of female faculty is still relatively low compared to the proportion of women in undergraduate studies.

Research on institutional values and norms points to gender inequalities in academia which are deeply rooted in the academic culture itself, its symbolic practices, and career constructions (e.g., Krais, 2000; Wobbe, 2003; Heintz, Merz and Schumacher, 2004). Two important conclusions can be drawn from these studies. First, the prevailing work norms, career expectations and age barriers as well as the view of "scientific life as a life-form" (Krais, 2008) make it more difficult and demanding for women than for men to reconcile family and career (Dressel and Langreiter, 2008; Jacobs and Winslow, 2004; Merz and Schumacher, 2004). Female

⁴ In contrast to the conception of Bourdieu, the phenomenon of cumulative advantage, described by Robert K. Merton (Merton, 1988), has to be understood as an outcome of a social psychological effect (bias of perception). This phenomenon is not in line with the normative conception of science and interferes with the development of science. Cumulative advantage therefore is a disruptive factor in academia which has to be omitted.

⁵ www.bfs.admin.ch/bfs/portal/de/index/themen/15/06/key/ind1.indicator.10309.102.html?open=145,143#143 (accessed 30 November, 2009).

academics generally cannot rely on a partner who takes care of or organises child-care on weekdays and, as a consequence, reduces his employment to part-time or even more (e.g., unpaid leave), a picture that is very well found for male academics (Leemann et al., 2010; Young et al., 2009; Lind, 2008; Majcher, 2007; O’Laughlin and Bischoff, 2005; Mason and Gouldon, 2004). Parenthood thus places limits primarily on the women’s availability for academic work – attending conferences, research time, networking opportunities and geographic mobility (Lind, 2008; O’Laughlin and Bischoff, 2005), and leads to problems of compatibility (Spieler, 2004). Emerging female researchers often fit their mobility to suit family plans, restrict their movements in terms of time and space, or dispense with academic mobility altogether (Leemann, 2010).

Second, within the male dominated competitive structure of the academic field, women are never the first to be included in the “arena of contest”, the symbolic struggles for university power and academic recognition (Krais, 2000). Since academic reputation can only be developed through social engagement with “the same” and through recognition and appreciation by “the same” (Bourdieu, 1997; 204; Beaufaÿs, 2003), women are often excluded from the competition. This is confirmed by the observation that women are less likely able to count on an academically established person who provides support and promotes their careers (e.g. Leemann et al., 2010; Zimmer, Krimmer and Stallmann, 2007, 122f.; Allmendinger, Fuchs, von Stebut, 2000; Grant and Ward, 1995). In general, women have more difficulties finding collaboration partners and are more often excluded from academic networks and associations than their male colleagues (e.g. Lang and Neyer, 2004; Leemann, 2002; Kyvic and Teigen, 1996; Sonnert and Holton, 1995), and they find it more difficult to build up collaborations with researchers abroad (Lewison, 2001).

While these factors point to substantial gender differences in the academic field, it remains an open question as to whether and when the equal opportunity programmes at Swiss universities do show an impact. Overall, however, we can assume that female academics still face greater problems when they pursue an academic career. They have more difficulties in accessing academic networks, and academic mothers in particular, especially when they have young children, are hindered in building up and maintaining academic contacts since they do not have the time resources available that are needed for it.

3 Postgraduate education

3.1 Individual data from the Swiss Higher Education Information System

Usually, gender-specific loss-rates are determined by cross-sectional analyses, which compare the proportion of women at various career stages within a particular reference year (European Commission, 2006, 55). Methodologically, however,

the cross-sectional comparisons are rather problematic. They mask the temporal dimension of the academic career path, and thus do not clarify whether the low proportions of women are a result of current or past discrimination. If the latter were the case, then the increasing proportion of women engaged in university study would “automatically” be carried over in time to the higher career levels. With cross-sectional analyses it also remains unclear what effect outflux and/or influx have on the respective numbers.

These deficits can be partially adjusted by considering an average expected time for each career step (e.g. 4 years between master’s and doctoral graduation). With “artificial” cohort analysis one can for instance compare the proportion of female doctorates in year t with the proportion of female masters graduates in year $t-4$ (BMBF, 2008, 111–119; Bund-Länder-Kommission, 2005, Part II). Nevertheless, this is only a rough approach because one does not know to how many observed graduates the assumed duration of the career step applies in reality.

With data taken from the Swiss Higher Education Information System (SHIS) on the individual educational paths of university students, we are able to carry out progress analyses of the transition from master’s to doctorate and the transition from doctorate to habilitation. Each student of the Swiss university system gets a student number (matriculation number) right at the beginning of his/her studies that remains the same up to the doctorate, regardless of interruptions of the studies or changes of the subject area or study place (inside of Switzerland). This number allows to identify if and at what time a student started and finished a doctorate. For the habilitation, the approach has to be adjusted, since the student number is not used in the habilitation period. Nevertheless it is possible to reconstruct habilitation behaviour in a longitudinal perspective and on the individual level.⁶ Students, and academics, respectively, who leave the Swiss university system after graduation and go for their doctorate or their habilitation abroad cannot be identified and monitored anymore and are in consequence not part of the data and the analysis.

3.2 Gender-specific transition rates from master to doctorate and habilitation

3.2.1 *Doctoral period*

Information on master’s and doctoral degrees is available as from 1978 onwards. If we investigate transition rates to doctorate for the older cohorts, the proportion of doctorates stabilises only 10 to 15 years after master’s graduation. For instance, the doctoral rate of the 1980-cohort amounts to 19% in 1985, to 30% in 1990 and to 32% in 1995. With younger cohorts, of course, the monitoring period has to be shortened. Therefore, we have restricted the following analysis to a (monitored) time span between master’s and doctoral degree of five years.⁷ This limitation has to be

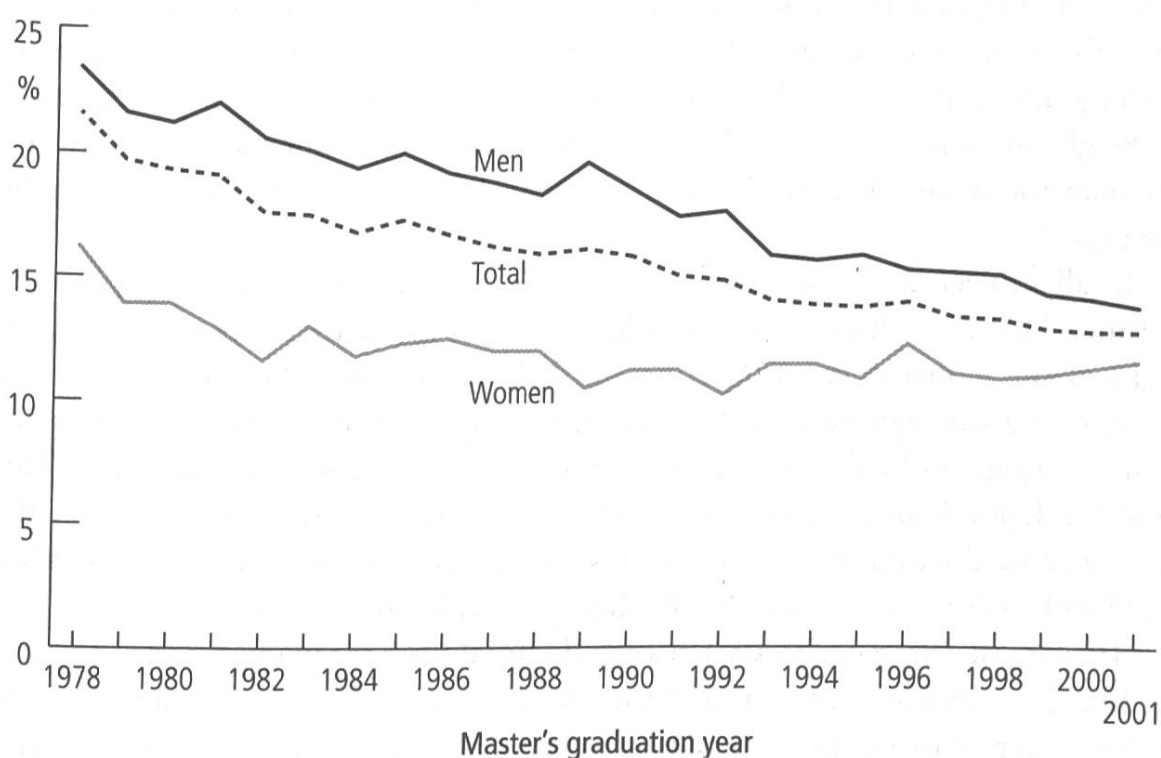
⁶ Further information on this approach is available from the authors.

⁷ The doctoral rate ten years after graduation is about 1.5 times higher than the doctoral rate five years after graduation (e.g. graduation year 1996: 20.1% vs. 13.9%). The differences between

considered while interpreting the results. A doctoral rate of 10% for example does not mean that only 10% of the master's graduates will ever be awarded a doctorate, but that 10% of them did so in the first 5 years following their degree.

An overall comparison of doctoral rates (see Figure 1) shows that since 1978 for every master's graduation year the rates have been higher for men than for women. Until the end of the 1980s (master's graduation year), the doctoral rate of male graduates was about twice as large as the rate of female graduates. Since the 1990s, a convergence of gender-specific doctoral rates can be observed. This, however, can be predominantly ascribed to the fact that the doctoral rate of male graduates has been decreasing over the long term (see Babel and Strubi, 2008). Compared to the cohort of the 1990 graduates, where 19% of the men have been awarded a doctorate within five years, the respective proportion is only 14% in the cohort of 2001. When we consider the rate of female doctorates during the last decade, we observe a relatively stable quota of 10% to 12%.

Figure 1: Doctoral rates five years after the award of the Master's degree



Source: Swiss Higher Education Information System (Federal Statistical Office), own calculations.

This global picture, however, masks the fact that doctoral rates vary considerably among the subject areas. In disciplines where the doctorate is of direct relevance

subject areas do not change substantially; the same holds true for the gender-specific doctoral rates. For the graduation years 1992 to 1996, for instance, the doctoral rate of men exceeds the doctoral rate of women by factor 1.43 five years after graduation and by factor 1.39 ten years after graduation.

to the non-academic labour market, the doctoral rates are above average (see also Engelage and Schubert, 2009). In medicine and pharmacy nearly 50% of the master's graduates have been awarded a doctorate within five years, in natural science the respective proportion is around a quarter. In contrast, the doctoral rates in the other academic fields are much lower and do not reach 10% within the first five years after master's graduation.

Furthermore, while interpreting the figure, we have to account for the different compositions concerning the subject areas of the master's cohorts during the last three decades. Worth mentioning is the large increase of graduates with a master's degree in the social sciences and humanities, while in medicine/pharmacy the number of graduates was stagnant or declining. The latter for instance is responsible for the continuous decline of the overall doctoral rate since the 1970s, although a trend with a comparable regularity is not observed when one is looking at each single subject area.⁸

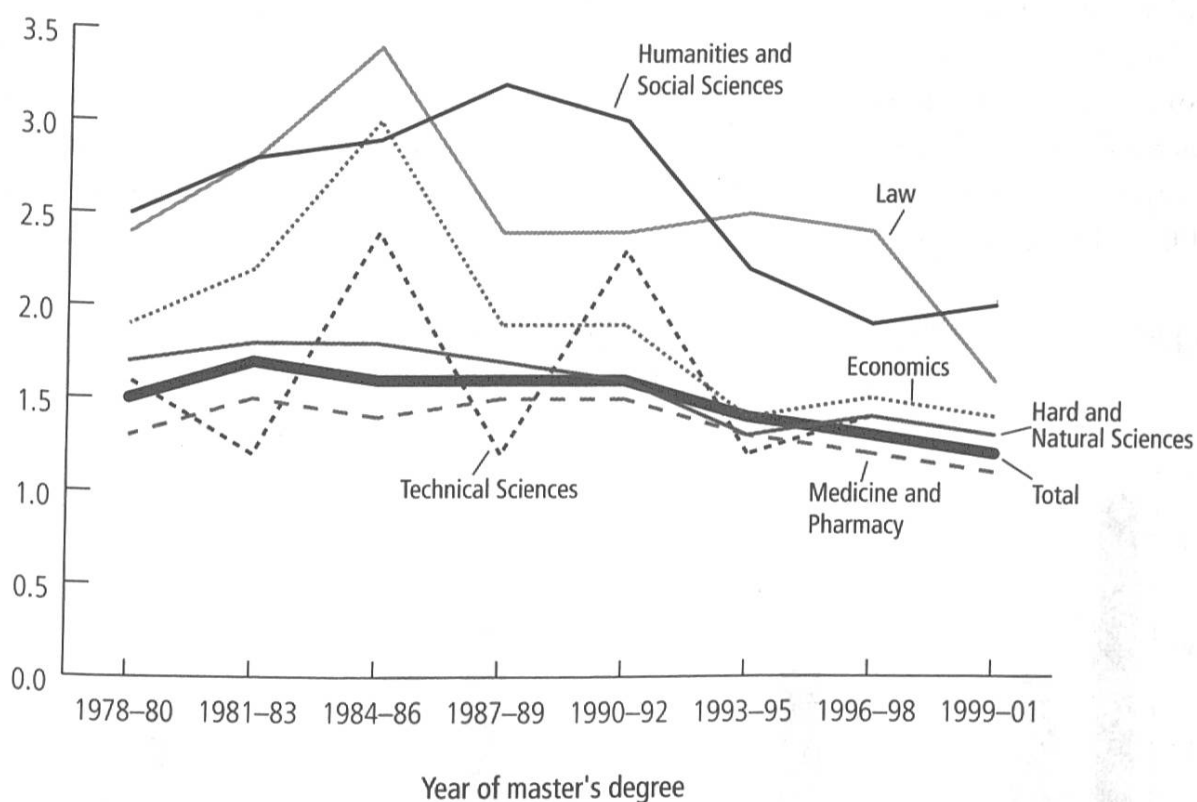
A more precise picture of the gender-specific chances of being awarded a doctoral degree can be obtained if we control for the different subject areas. Figure 2 shows the proportion of doctoral rates for men relative to the doctoral rates for women five years after the award of the master's degree, broken down by subject area and graduation year (each bar spans a block of three years). The quotas confirm the global picture of Figure 1: The doctoral rates for women are nearly always lower than the doctoral rates for men, and hence, no bar in Figure 2 has a value lower than 1.

In all subject areas, the doctoral rates for women and men have converged over time. However, this development has been less linear than one would assume in light of the global doctoral rate: up until the mid-1980s the doctoral rates in most subject areas registered an increase in the gap between genders. Only since then has the gap gradually been closing, above all in medicine and pharmacy. This second tendency is ultimately the stronger of the two: in each subject area, the gender-specific doctoral rates associated with the most recent master's graduation years (1999 to 2001) are more closely aligned than in the earliest years.

The largest difference today between doctoral rates for women and for men is to be found in the humanities and in the social sciences. This contradicts the view that the career chances are particularly good for women in those disciplines with the highest degree of female participation (according to the "contact thesis", see Leemann, 2002, 64 ff.). If anything, the contrary seems to apply: In physics, for

⁸ Despite the overall decreasing doctoral rate, the total number of doctorates awarded by Swiss universities has increased. On the one hand, this has to be traced back to the fact that the number of master's degrees – the amount of graduates that can start with doctoral studies – since the end of the 1970s has nearly doubled. On the other hand, doctorates who did their master's degree abroad and entered the Swiss university system for their doctorate are not part of the sample. Therefore, we have to take into account that due to this academic influx the number of doctorates is higher.

Figure 2: Relation between doctoral rates for men and for women within five years of earning the Master's degree (by subject area)



Source: Swiss Higher Education Information System (Federal Statistical Office), own calculations

Key: Of the people who received a Master's degree in law between 1993 and 1995, for example, the fraction of men who earned a doctorate within five years is 2.5 times higher as the fraction of women.

instance, women usually represent less than a tenth of the students who graduate with a master's degree, but the doctoral rates for women and for men are relatively close. Similar results hold for several branches in the technical sciences.

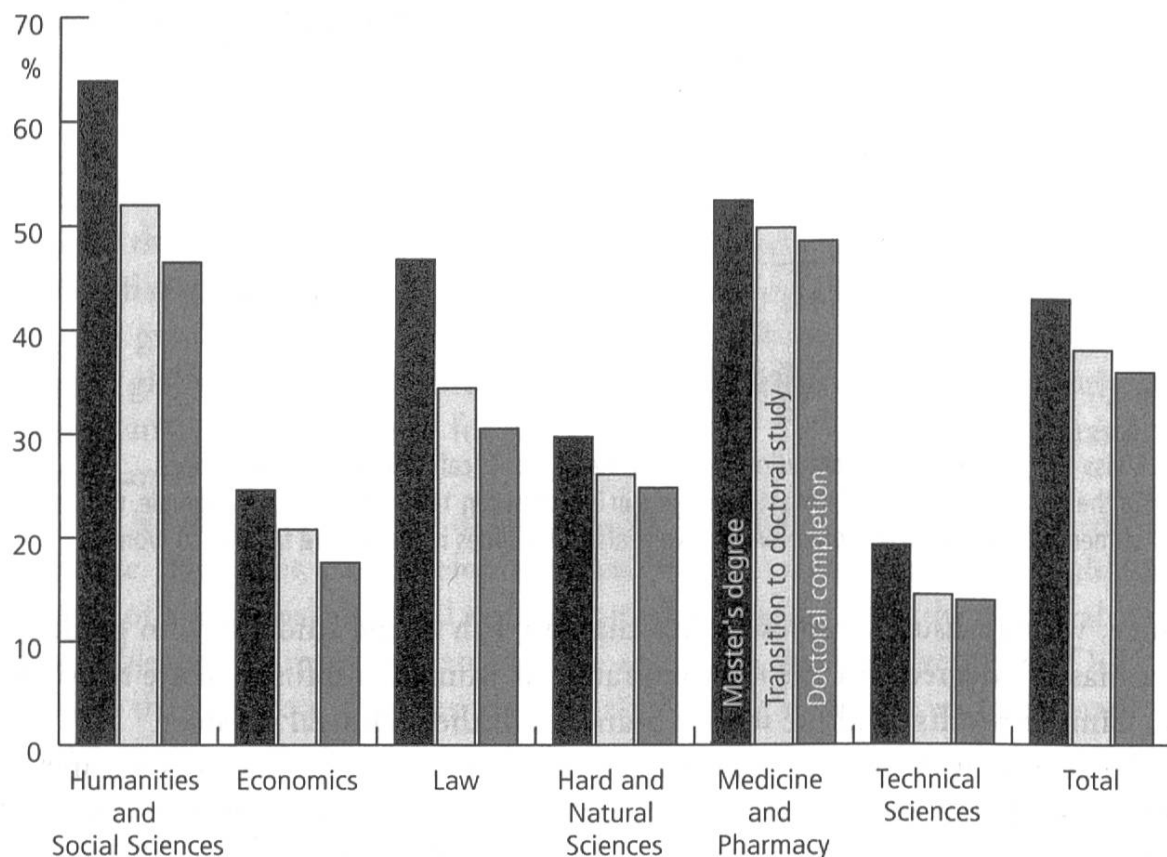
These findings tend to support two arguments: First, in situations of significant underrepresentation, women who decide for a doctorate are especially motivated and qualified ("positive selection") or they might profit from their unique and special status (see Leemann, 2002). Second, in disciplines with high paradigmatic consensus, women are taken more seriously as researchers because the habitus and hence social origin or gender identity play a subordinate role in research success (Hargens and Hagstrom, 1982). This argument in particular would explain the large gender-specific differences in the social sciences, as a field of study with great paradigmatic heterogeneity, and the relatively low differences in the hard and natural sciences.

Figure 3 shows the "cohort controlled" proportion of women⁹ on three different career levels: the master's degree, the transition to doctoral study and the

⁹ In this case the proportion of women is not calculated for all doctorates of a given year (of doctoral graduation), but only for the people of a specific cohort (of master's graduates) having earned a doctorate within five years.

completion of the doctorate. This more detailed view of the doctoral phase shows where women lose the most ground. In the humanities and social sciences, law and technical sciences, women decide much less frequently than men to pursue a doctorate. Between starting and completing the doctorate, the proportion of women drops less drastically. The “pipeline” is thus “leakiest” in the transition to doctoral study. Once women decide to do a doctorate, they are nearly as likely to complete it as men (for comparable findings, see Leemann, 2002; Lind and Löther, 2007; Hinz et al., 2008).

Figure 3: Proportions of women (Master’s degree: 1997–2001) making the transition to doctoral study



Source: Swiss Higher Education Information System (Federal Statistical Office), own calculations.

Key: In the humanities and social sciences 64% of all people who completed a Master’s degree between 1997 and 2001 were women. Of the graduates in the humanities and social sciences between 1997 and 2001 who then decided to proceed to the doctorate, 52% were women. Of these same graduates who completed the doctorate within five years of graduating with the Master’s degree, 47% were women.

It remains an open question if the observed equalisation of gender-specific graduation rates on the master’s level (with a switch to slightly more female than male graduates in 2006¹⁰) will be fully transmitted to an equalisation of relative proportions of male

10 See also Federal Statistical Office: <http://www.bfs.admin.ch/bfs/portal/de/index/themen/15/06/key/ind1.Document.48480.xls> (accessed 30 November, 2009).

and female graduates on the doctoral level, or if the gender differences remain on this stage of the academic career due to some other science internal or external factors.

3.2.2 *Habilitation*

The Swiss Higher Education Information System has data on all habilitations at German-speaking universities since 1992. Up to 2006, data on 2480 habilitations is available.¹¹ The data not only contains information on the habilitation, but also on the doctorate (point of time, university) and therefore allows shedding “statistical light” on the career period between doctoral graduation and habilitation.

In what follows, the transition from doctorate to habilitation is analysed and described in a similar way as before the transition from master’s to doctoral graduation. We focus on the cohorts of doctorates and investigate how many doctorates acquire a habilitation degree within a specific time span. Based on our data we can analyse reliably the qualification behaviour of the cohorts of doctorates from 1990 onwards.

If the investigation period is set at twelve years after being awarded a doctorate, then the habilitation rates lie between 4% and 6%.¹² When we compare the habilitation rates for women awarded a doctorate between 1990 and 1994 with those for men awarded a doctorate in the same years, significant differences appear in three subject areas as well as in the overall total. The largest gap, to the disadvantage of women, is in medicine and pharmacy. This subject area, which seems open to and supportive of women at the doctoral level, becomes far less so at the habilitation stage. The proportion of women who habilitate within twelve years of completing a doctorate is four times smaller than that of men (1.2% vs. 5.1%). Since over a third of the habilitations under consideration belong to this subject area, this inequality has a strong effect on the overall picture. Women also have significantly lower habilitation rates in the hard and natural sciences (1.4% vs. 3.6%) as well as in the humanities and social sciences (7.2% vs. 11.8%).

At the current stage, we can evaluate precisely enough the habilitation rate for the 1990- to 1994-cohorts of doctorates. Future analyses with subsequent cohorts have to validate these preliminary results.

11 Not included in this data are the so called “Umhabilitationen”, a procedure which grants the right to teach at an additional University as a private lecturer.

12 In most subject areas, 70% to 80% of those undertaking a Habilitation acquire it within twelve years of earning a doctorate. We can assume, however, that when habilitations are presented much later than this, they are no longer directly relevant to a university career.

4 Integration in academic networks

4.1 The survey of 2002 doctoral graduates (panel 2003/2007)

With data from the Swiss Graduate Survey regularly carried out by the Swiss Federal Statistical Office (FSO), we are able to investigate the integration of doctoral graduates into the scientific community five years after their graduation and to explain which (dynamic) factors allow them to build up a relevant academic network. All university graduates awarded a doctorate in 2002¹³ were questioned in 2003 and 2007 by the FSO on their career development, family situation, social background and other socio-economic factors.

In the wave of 2003, there was an additional module inserted in the context of evaluating the Swiss Federal Equal Opportunity at Universities Programme with questions on support at universities and on participation in different promotion programmes during the doctoral period (Bachmann and Müller, 2005). A supplementary module was also included in the 2007 wave in the context of our study on topics of academic career. In particular, we have collected data on academic integration and research funding.¹⁴

Compared to the initial population of doctoral graduates in 2002 (N = 1689), there were 538 people in the second wave with valid entries for both surveys, which yields a total return rate of 31.9% (see Table 1).

Table 1: Response rate of the waves of 2003 and 2007

Wave 2003				Wave 2007						
Initial population		Questionnaires (completed)	Response rate 2003	Initial population*		Questionnaires (completed)	Response rate 2007	Response rate in total	Response rate supplementary modul	
Number	%	Number	%	Number	%	Number	%	%	Number	%
1689	100	753	44.6	753	100	538	71.5	31.9	470	27.8

Source: Swiss Graduate Survey (Federal Statistical Office).

* All doctoral graduates of 2002 who took part in the wave of 2003 and could be reached in 2007 by mail.

The response rate of the first wave was rather low (45%) which can mainly be explained by the contents and formulations of the questionnaire with the target group being all students with a master's degree and not considering that part of the sample awarded a doctorate in 2002. In the context of our study, we had the opportunity

13 With the exception of a) the University of St. Gallen and the University of Basel, which did not supply the addresses of doctoral graduates, and b) the area "medicine and pharmacy", which contributed only a few isolated subjects as the graduates were only included if they passed the state examination at the same time (due to the different significance attributed to the doctorate in medicine).

14 The questionnaires are available online: http://www.bfs.admin.ch/bfs/portal/de/index/infothek/erhebungen_quellen/blank/blank/bha/02.html (accessed 30 November, 2009).

to revise and modify the questionnaire in cooperation with the FSO, and, as a result, 72% of the population of the first wave completed the questionnaire in the second wave. Since not all respondents filled out the supplementary module, the available number of observations comes down to 470 people, which yields a total return rate of about 28 %.

A comparative analysis of the two samples (all respondents of the second wave and reduced sample of the supplementary module) shows no significant differences in the distribution of gender, region, and disciplines. Therefore, we deem it reasonable to assume a random drop out of doctoral graduates from the survey and employ weights in all steps of the analysis.¹⁵ The weighting factor provided by the FSO indicates the inverse probability that a particular observation based on the sampling design will be contained in the sample. All calculations are carried out in Stata (Version 10).

4.1.2 Dependent variables

In order to measure the integration in academic networks, the respondents were asked in the 2007 wave how often they currently have contact with university professors and senior researchers at universities in Switzerland and abroad. The response categories ranged from “1” (not at all) to “5” (very frequent). The numbers in between (“2”, “3”, “4”) did not have a verbal specification. Four dependent variables have been constructed: Qualitative statements on the frequencies of contacts to 1) University professors in Switzerland, 2) University professors abroad, 3) Senior researchers at universities in Switzerland, and 4) Senior researchers at universities abroad.

4.1.2 Explanatory variables

Besides a range of sociodemographic variables (such as gender, age, parental education, and the birth of children), the multivariate analyses control for two sorts of university factors, the subject area and the university (German as opposed to the French speaking part of Switzerland) of the doctoral graduation. In order to measure long-term effects of integration on the academic network, and thus capture the dynamics of network creation, we use information gathered in the first wave of the panel survey: Position as an assistant, the participation in a postgraduate programme and/or in a mentoring programme¹⁶, and subject-specific and career-oriented support¹⁷.

¹⁵ According to the official information provided by the FSO, the weights should be used in the analyses in order to obtain results for the initial population of doctoral graduates. Two crucial assumptions have to be made when implementing the weighting approach. First, observations have to be missing at random, and second, model parameters have to be homogeneous across certain subpopulations. While there is some evidence in favor of the first assumption, we deem it reasonable to make the second assumptions due to the limited data availability.

¹⁶ For further information on the mentoring programmes see <http://www.crus.ch/information-programme/equal-opportunity.html?L=2> (accessed 30 November, 2009).

¹⁷ Further information on the construction of the different variables are available from the authors.

The integration after the doctorate is captured by the question of employment in academia immediately following the degree. Furthermore, we take into account whether the respondent got support by research funding: in minimum one fellowship from the SNSF or from another institution approved, and/or at least one project funding from the SNSF or another institution approved. These variables have been constructed from the information in the second wave.

4.2 Methods

The integration into scientific networks is estimated using a dynamic model capturing the intertemporal aspect of creating, establishing, and maintaining contacts to other researchers. More specifically, the model we think of when analysing networks has the form

$$(1) \quad Y_t = f(X_t, X_{t-1}, U_t)$$

where Y_t is the strength of the network at time t , i.e., at the time of the second round survey in 2007, X_t is a vector of explanatory variables observed in time t , X_{t-1} is a vector of pre-determined variables observed at the time of the first round survey in 2003 (which may include time-constant variables such as gender), and U_t is an idiosyncratic error term. The function f describes how the (strength of the) network depends on these factors. We explicitly model the dynamics in the network determination in order to account for expected adjustment processes, e.g., through the academic integration during the doctorate, that do not affect the network immediately, but only in the long term.

The model is parameterised by specifying a function f and a distribution of the error term. We assume the following structure accounting for the ordinal nature in the qualitative statement about the frequency of contacts:

$$(2) \quad Y_t = j \text{ if and only if } \kappa_{j-1} < \alpha X_t + \beta X_{t-1} + U_t \leq \kappa_j \quad j = 1, \dots, 5$$

$$(3) \quad U_t | X_t, X_{t-1} \sim \text{Normal}(0, 1)$$

where j is an index for the ordered categories running from “1” (no contacts at all) to “5” (very frequent contacts). The parameters κ_j are threshold parameters that characterize the frequency of contacts depending on the value of the linear index $\alpha X_t + \beta X_{t-1} + U_t$. Thus, according to the model the higher the value of the latent index, the higher the outcome of the response variable, i.e., the strength of the network, for a given set of threshold values. In order to obtain a well-defined probability model we assume that $\kappa_{j-1} < \kappa_j$ ($j = 1, \dots, 5$), $\kappa_0 = -\infty$ and $\kappa_5 = \infty$ so that each possible value of the linear index is associated with exactly one value of the response variable. The assumptions yield the following probability model:

$$(4) \quad P(Y_t = j | X_t, X_{t-1}) = \Phi(\kappa_j - \alpha X_t - \beta X_{t-1}) - \Phi(\kappa_{j-1} - \alpha X_t - \beta X_{t-1}) \\ j = 1, \dots, 5$$

where Φ is the cumulative distribution function of the standard normal distribution. This is a modified ordered probit model that accounts for the dynamics in the network determination (see McKelvey and Zavoina, 1975; McCullagh, 1980; Boes and Winkelmann, 2009, Ch.6, for further details on the ordered probit and related models). The parameters of interest are α and β . Regarding the dynamic aspect of the model, the former determines the marginal or discrete effect of current characteristics (or characteristics measured in t) on the probabilities of observing a particular strength of the academic network, the latter determines the effects of the pre-determined variables (measured in $t-1$) on the network.

4.3 Unequal access to international academic networks

Table 2 presents the estimation results for the extent of academic contacts to professors in Switzerland and abroad, and to senior researchers in Switzerland and abroad. Each model includes the variables observed at the time of the second wave, i.e., at the time when respondents gave their subjective opinion about the strength of the network, as well as the pre-determined variables that have been recorded at the time of the first wave. The variable of major interest is the gender dummy, taking value one for women and zero otherwise.

As a main result, we find that female academics have about the same extent of academic networks established within Switzerland than men, but they report significantly fewer contacts to professors and senior researchers abroad. For example, the probability of reporting no contacts with professors abroad is predicted as about 24.6% for men (with all explanatory variables evaluated at the mean), while the same probability is predicted about 37.3% for women.¹⁸ About the same difference holds for no contacts to senior researchers abroad. This result indicates that women encounter more problems in gaining access to the international academic world, which, as a consequence, may lead in the long run to women not being as competitive in recruitment and selection processes as men, and thus dropping out of the academic career in a stage before obtaining a professorship.

The reasons for the weaker integration in international networks are multifaceted, as our own data substantiate. For example, considering the likelihood of being mentored by a university professor, we observe that female upcoming researchers have less than half of the chances of male researchers of finding a mentor in the postdoc phase (Leemann et al., 2010). Furthermore, women encounter more problems to go abroad for a research period because their partners are less willing or able to accompany them (Leemann, 2010).

18 The linear index of the regressors except for gender evaluated at the mean values is estimated as about 0.716. The probability of no contacts for men can therefore be estimated as $\Phi(0.0298-0.716)=0.246$. The corresponding probability for women is estimated as $\Phi(0.0298-0.716+0.363)=0.373$. The difference of 12.7 percentage points can be interpreted as discrete probability effect of gender on the probability of no contacts.

Table 2: Determinants of academic contacts five years after the doctorate

	University professors		Senior researchers at universities ...	
	in Switzerland	abroad	in Switzerland	abroad
Socio-demographic factors				
Woman	-0.130 (0.152)	-0.363** (0.149)	0.0291 (0.146)	-0.273* (0.145)
Age	0.042** (0.018)	0.004 (0.017)	0.052*** (0.018)	-0.015 (0.017)
Masters Degree abroad	0.091 (0.155)	0.584*** (0.151)	-0.144 (0.149)	0.406** (0.153)
Father university degree	0.111 (0.132)	0.116 (0.150)	0.237* (0.135)	0.208 (0.153)
Mother university degree	-0.381* (0.197)	-0.240 (0.214)	-0.250 (0.193)	-0.127 (0.222)
Birth of child after doctorate	0.0067 (0.132)	-0.362*** (0.129)	-0.047 (0.128)	-0.537** (0.136)
University factors				
French-speaking part of Switzerland	0.240* (0.138)	0.0982 (0.141)	-0.308 (0.151)	0.026 (0.147)
Subject area (natural sciences = base)				
Social sciences and humanities	0.231 (0.219)	-0.042 (0.189)	-0.087 (0.204)	-0.224 (0.196)
Economics	-0.098 (0.202)	-0.252 (0.355)	-0.231 (0.218)	-0.399 (0.317)
Law	0.373 (0.301)	-0.437 (0.358)	-0.144 (0.273)	-0.667** (0.317)
Medicine/pharmacy	-0.089 (0.407)	-0.216 (0.376)	-0.289 (0.395)	-0.460 (0.549)
Technical sciences	-0.024 (0.169)	0.040 (0.163)	0.097 (0.176)	-0.066 (0.163)
Integration during the doctorate				
Position as assistant	0.087 (0.155)	0.017 (0.144)	0.016 (0.147)	-0.152 (0.149)
Participation in a post-graduate programme	0.024 (0.210)	0.193 (0.220)	0.208 (0.220)	0.627** (0.199)
Subject-specific support during doctorate	0.090* (0.053)	-0.005 (0.049)	0.116** (0.053)	-0.021 (0.047)
Career-oriented support during doctorate	0.230** (0.093)	0.163* (0.098)	0.161* (0.092)	0.246** (0.108)

Continuation of table 2 on the following page.

Continuation of table 2.

	University professors		Senior researchers at universities ...	
	in Switzerland	abroad	in Switzerland	abroad
Integration after the doctorate				
Position in academia	0.232 (0.141)	0.532*** (0.135)	0.347** (0.143)	0.568** (0.138)
Support by research funding				
Fellowship from SNSF approved	0.0594 (0.180)	0.524*** (0.202)	0.0209 (0.162)	0.361** (0.175)
Fellowship from other institution approved	-0.128 (0.199)	0.361 (0.220)	-0.116 (0.183)	0.310 (0.209)
Project funding from SNSF approved	0.762*** (0.276)	0.312 (0.250)	0.817*** (0.266)	0.450 (0.278)
Project funding from other institution approved	0.335* (0.174)	0.375** (0.166)	0.248 (0.175)	0.327* (0.167)
κ_1	1.396* (0.738)	0.0298 (0.687)	1.835** (0.784)	-0.865 (0.708)
κ_2	2.232*** (0.745)	0.753 (0.687)	2.553*** (0.786)	-0.168 (0.709)
κ_3	2.877*** (0.752)	1.335* (0.693)	3.113*** (0.788)	0.406 (0.702)
κ_4	3.441*** (0.752)	1.930*** (0.700)	3.703*** (0.788)	1.020 (0.703)
N	353	353	353	353
Log-likelihood	-529.2	-496.7	-530.9	-490.1
Model Chi-squared	59.00	93.19	65.56	108.0
Degrees of freedom	21	21	21	21

Source: Swiss Graduate Survey (Federal Statistical Office), own calculations.

Notes: Modified ordered probit model. Reported numbers are the coefficients described in equation (4). Standard errors in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

Each outcome variable has 5 categories measuring the subjective intensity of the network from "1" (no contacts at all) to "5" (very frequent contacts). The threshold values characterize the frequency of contacts by mapping a latent linear index of observable and unobservable characteristics on the scale of the outcome variable.

The estimation results also show that age is an important determinant of building up academic networks in Switzerland, but not abroad, which points to the fact that older graduates are often less able to stay abroad during their postdoctoral phase (due to family responsibilities and the like) and therefore invest more in networks with researchers that are geographically close. Although insignificant for networks abroad, the positive sign of the age effect in all models justifies the notion that building up social capital requires life time.

Researchers with a master's degree from abroad are also better networked abroad, as expected. Having a father with a university degree positively affects

the number of contacts to other researchers, having a mother with a university degree shows the opposite effect, *ceteris paribus*. The effects are weakly significant or insignificant, however, which could possibly be explained by the fact that such academics are less dependent on mentors, because they have greater confidence in dealing with the academic field.

Our analysis substantiates that the birth of children after the doctorate impedes networking activities abroad.¹⁹ We expect that pre-school children hamper, for example, the possibilities of attending conferences or visiting a research institute abroad. Furthermore, the maintenance of academic contacts is time consuming, what poses problems especially for academics who have to reconcile family and work. Additional analyses (not shown in the table) reveal that this result holds for women and for men.

Regarding the other factors observed at the time of the first wave in 2003, language region and subject area of the doctoral graduation do not show important effects. Integration during the doctorate, however, is very important for establishing an academic network after the doctorate (participation in a post-graduate programme during the doctorate, career-specific support as well as subject-specific support). As our analyses show, there are significant long-term effects of being part of an academic setting and getting support and recognition on the ability and opportunities to build up scientific contacts in later steps of the academic career.

Among the determinants recorded at the time of the second wave, integration after the doctorate is an important determinant of building up a network. As one would expect, emerging researchers who hold a university position five years after their doctorate have built up a significant scientific network compared to those who left academia.

At least one successful application for individual research funding of the SNSF and other institutions supports network creation. In the case of the SNSF, this can be explained by the requirement of geographical mobility when researchers apply for a fellowship. For other funding institutions, we observe that these are typically located abroad, and hence applications are submitted by researchers who are already internationally oriented. SNSF project funding, by contrast, tends to mainly support academic networks within Switzerland. However, these results must not be interpreted as uni-directional; rather, it can be assumed that a larger, more international network leads to increased opportunities and better perspectives in research funding at home and abroad.

19 According to our hypothesis, older children (born before the doctorate) are no more a barrier in building up and maintaining a scientific network.

5 Summary and discussion

Despite the equalisation of male and female educational chances on the tertiary level, important gender inequalities develop after the completion of a master's degree. In this article, we point to two dimensions of the "Leaky Pipeline". On the one hand, there still exist gender barriers in the access to institutionalised cultural capital (doctorate and habilitation), and on the other hand, women encounter more difficulties in settling in the international academic field and building up social capital.

Our analyses of individual data from the Swiss Higher Education Information System (SHIS) substantiate that over the last three decades the doctoral rates of women in all subject areas are nearly always lower than the doctoral rates of men. Since the 1990s, however, we observe a convergence of gender-specific doctoral rates. The largest difference between women and men today is found in the humanities and the social sciences, which contradicts the hypothesis that career chances are particularly good for women in those disciplines with the highest degree of female participation. Similar results hold for the process of habilitation.

In the highly competitive academic job market, social contacts become an ever more important ingredient. Such contacts lead to further acquaintances and collaborations, which in turn increase a researcher's visibility, reputation, integration and productivity, or in other words: generate cultural and symbolic capital. Based on a rich panel dataset of all university graduates awarded a doctorate in 2002 (drawn from the Swiss Graduate Survey), we find a significantly poorer integration of young female researchers in academic networks five years after being awarded the doctorate. This, however, is only observed for contacts with professors and peers abroad, not for domestic contacts. Since an established international network is one of the pivotal factors when it comes to deciding whether or not an academic career is successful, or promising, the systematic lack of international social capital can be seen as a major cause for the leaky pipeline in Switzerland.

Two main conclusions can be drawn from our analyses. First, while we find important gender differences in the accumulation of international social capital, we also identify a number of supportive factors for the formation of an academic network, such as good integration in early steps of the career (in form of programmes or individual support by mentors), or the successful participation in research funding (although the latter may not only be uni-directional). Hence, a change in institutional settings may help young female researchers to have a better access to these factors, and may thus reduce the currently observed inequality.

Second, the reconciliation of family and work is still a key factor in the development of an academic career. In particular, our analyses reveal that the birth of a child after the doctorate is a significant barrier for international networking activities, presumably due to a reduced geographical mobility and the reallocation of time resources. Again, a change in the demand and cultural beliefs that have been

established in the scientific community over the last decades may help to increase the share of female academic professionals.

Our analyses are partly limited by the data availability. Ideally, we would like to draw from a large pool of doctoral graduates that we can follow over their life cycle. However, this is not possible for several reasons. First, the systematic acquisition of data on career trajectories of doctoral holders has started only very recently and the collected data do not focus primarily on *academic* careers, making it difficult to infer long-term effects of social capital on academic job market chances.²⁰ Second, the Swiss academic job market is rather small placing strict limits on available sample sizes. Third, and partly related to the second point, the outside options in the Swiss job market are very good, and a more comprehensive analysis would account for possible job offers from the non-academic sector in *each* step of the career (the Swiss Graduate Survey only provides limited information regarding this aspect). We therefore leave these issues for future research taking advantage of the newly available data sources.

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20 The OECD together with the UNESCO Institute for Statistics and Eurostat launched a new project on careers of doctorate holders in 2004 that targets a systematic collection of indicators on academic careers and labour market mobility, see http://www.oecd.org/document/63/0,3343,en_2649_34409_39945471_1_1_1_1,00.html (accessed 30 November, 2009).

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