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Discussion Papers

Is There a Doctor on Board? Collecting Generalizable Data on Doctoral Candidates in Germany

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DIW Berlin
German Institute for Economic Research
Mohrenstr. 58
10117 Berlin

Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
<http://www.diw.de>

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**Is there a doctor on board?
Collecting generalizable data on doctoral candidates in Germany**

Anna Fräßdorf and Mathis Fräßdorf

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Contact details

Anna Fräßdorf
Humboldt-Universität zu Berlin
Humboldt Graduate School
Unter den Linden 6
10099 Berlin
email: anna.fraessdorf@hu-berlin.de

Mathis Fräßdorf
DIW Berlin
Mohrenstraße 58
10117 Berlin
email: mfraessdorf@diw.de

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Collecting generalizable data on doctoral candidates in Germany

Abstract

Despite of its relevance for science policy and the scientific community, empirical research on doctoral education in Germany is sparse. The few papers available face challenges in the sampling approach: simple random sampling is not possible, because a universal register of PhD candidates in Germany does not exist yet. This article focuses on the issues related to possible data collections for the purpose of research with respect to PhD candidates in Germany. We first outline which official information on doctoral candidates is currently available. We then give an overview of the main German survey studies on doctoral candidates with a focus on their respective sampling strategies. Finally, we discuss the three approaches which conceivably enable researchers to conduct statistical inference on the population of doctoral candidates in Germany: sampling via stratified clusters based on universities or faculties, sampling based on a screening approach, and respondent driven sampling.

Keywords: doctoral education, science policy, PhD candidates, sampling, data collection

JEL: C83, I23

1 Background

Traditionally, doctoral education in Germany was characterized by a one-on-one relationship in an apprenticeship model. The doctoral supervisor (“Doktorvater/-mutter”) would take the doctoral candidate under his/her wings, the candidate would mainly benefit from the advisor’s wisdom, and in due course, the early career scientist would become a fully able researcher qualified to hold the PhD title (e.g. Enders 2004, p. 424 f.). In the last decades, however, the training of PhD candidates in Germany has been debated, both within the scientific community and from the political point of view. The debate was also influenced by efforts to harmonize scientific pathways across Europe¹, promoting structural PhD programs (cp. the European University Association’s Salzburg Recommendations² or the European Commission’s Principles for Innovative Doctoral Training³). Following the debate, the German government set the goal to develop Germany into an internationally renowned place for early career scientists (Bundesministerium für Bildung und Forschung 2006, p.12). However, how to assess and assure the quality of doctoral education remains an open question so far (see for example Wissenschaftsrat 1996, 2002, 2011; Hochschulrektorenkonferenz 1996, 2003, 2012).

Up to now, little is known about doctoral candidates in Germany and the structural details of their postgraduate education. Several delegates of the German Bundestag criticized this fact in a common notion in 2012⁴, stating that systematic data on the qualifying process of early career academics were missing, including failure and success rates. The delegates also noticed that without data, research on the situation of early career scientists is virtually impossible. Generalizable data on doctoral candidates are thus imperative not only from a scientific but also from a political point of view, calling for a data collection effort on PhD candidates in Germany. The debate eventually induced an amendment of the law on higher education statistics (Hochschulstatistikgesetz HStatG) in Germany, which in its new version stipulates the collection of data concerning doctoral candidature. However, the implementa-

¹ Commission of the European Communities (2007a, 2007b).

² European University Association (2005, 2010).

³ European Commission (2011).

⁴ Deutscher Bundestag (2012).

tion of comprehensive registration instruments in all German higher education institutions and thus the formation of a reliable database will still take some time.

This paper focuses on the issues related to possible data collections for research purposes with respect to PhD candidates. We first describe the situation regarding available data in Germany, and then relate to some existing research on doctoral candidates. We finish with some suggestions for future empirical studies.

2 Available information on doctoral candidates in Germany

In any study interested in gathering information on a specific population, it is important to define this population by certain measurable characteristics. To answer questions related to how individuals obtain their doctoral degree in Germany, the respective population of individuals first needs to be defined properly. This may already be a challenge, as several definitions of the beginning of the doctoral candidature are possible: having finished the prerequisite degree (usually a Master's degree or a diploma), the start of a PhD program, the taking-up of a qualification position as a research assistant, or a candidate's own assessment of when the doctorate started.⁵ For the purpose of this paper, the population may be loosely defined as those inclined to obtain a PhD, who also have an at least informal association with a university or faculty (only through those a PhD can be obtained in Germany). Our broad definition thus confines the population of doctoral candidates to those, who either are a member in a structured doctoral program or are affiliated with a university, officially or not, trying to receive doctoral honors.

In an ideal world (in the sampling sense), there would be a list of doctoral candidates, who have to register on the (well- defined) first day of their way to a PhD. From this universe of PhD candidates, a random sample could be drawn, possibly stratified by certain characteristics (e.g. field of study or sex). Such a random sample would allow conducting statistical inference on the population of doctoral candidates in Germany. Up to now, such a register does not exist (Hornbostel 2012; Senger & Vollmer 2011), and in many universities, a com-

⁵ Similarly, there is no clear definition of when the doctoral candidature ends: at the time of the dissertation's submission, the thesis defense or the conferral of the doctorate (cp. Deutsche Forschungsgemeinschaft 2011, p. 38 f.). On the discussion about the beginning and the end of a doctoral candidature see also Enders & Bornmann (2001, p. 65ff.); Kerst & Wolter (2010, p.123 ff.); Hauss et al. (2012, p. 35 f. and 71 ff.).

prehensive list of doctoral candidates is still missing. As such, a (simple) random sample of the population of PhD candidates in Germany cannot be drawn as long as the obligatory data collection based on the Hochschulstatistikgesetz is not exhaustively and comprehensively implemented at German universities and the registration at an early stage of the doctoral candidature is warranted.⁶

Although the complete population of PhD candidates in Germany is unknown at the moment, parts of it may be concluded from other sources. The Federal Statistical Office (Statistisches Bundesamt 2015a, 2015b) regularly collects data through the State Statistical Offices (“Statistische Landesämter”), which receive data on those enrolled as doctoral students (“immatrikulierte Promotionsstudenten”) as well as on those who earned their doctorate from the respective universities in the federal state (“Bundesland”)⁷. However, the Federal Statistical Office has the data available on an aggregated basis only, per-person (and contact) data can only be accessed via the single universities. Additionally, these data are not without issues if one is interested in the population of doctoral candidates.

The use of these data from the Federal Statistical Office forces a restriction of the population of PhD candidates to those enrolled as doctoral students at their university. Wolters & Schmiedel (2012, p. 5) estimate that a sample drawn from this population would represent about half of the doctoral candidates in Germany. Such a sample will likely not be representative of the true population of doctoral candidates: candidates who obtain an extra-occupational PhD next to a regular employment outside higher education institutions, for instance, would not be included if they are not enrolled. Similarly, the majority of those who obtain their PhD while working at the university, for example as a research assistant, would be left out, as they are in some cases explicitly forbidden to enroll as a student. Additionally, enrolling as a doctoral student may not be mandatory even for those who are entitled to do so (see Hauss et al. 2012, p. 57 f.; Blümel et al. 2012, p. 55 ff.). Hence, the group of enrolled candidates is selective, as it is likely to consist mainly of members in structural PhD programs or graduate schools.

⁶ On the difficulties linked to missing register data for sampling see, for example, Mecklenburg et al. (1997, p. 154 ff.).

⁷ These numbers are based on the universities’ registers. The universities need to send these numbers to the Land Statistical Office according to the “Gesetz über die Statistik für das Hochschulwesen” (HStatG).

While enrolled doctoral candidates per se may be a different group compared to those not enrolled, there could be other reasons for selectivity as well, among them the enrollment behavior, which may differ by field of study, or certain trends in science policy, which lead to a non-random foundation of graduate schools across fields of study. Besides focusing on enrolled doctoral candidates, it would be possible to consider only those who signed up for a PhD at a university. However, if candidates only register very briefly before their dissertation's submission, drawing a sample from this group might lead to selection towards those almost finished.

Based on the official records those with a completed doctoral degree could also be interviewed retrospectively (see Enders & Bornmann 2001) – with universities as gatekeepers for their contact data. While here the sampling frame is sufficient to obtain true PhDs, it fails to cover those who started a candidature but did not earn a degree. Success or failure rates cannot be calculated and reasons for success or dropout cannot be uncovered.

A further possibility to obtain a sample of PhD candidates exists on the university level: having access to universities' lists of current doctoral candidates. However, many German universities have not implemented the comprehensive registration of "their" PhD candidates yet. In that sense, samples obtained through such lists will likely suffer from a similar selectivity as the restriction to candidates enrolled as doctoral students if it cannot be ensured that all universities can provide an up-to-the-minute list of all current candidatures.

3 Studies on doctoral candidates in Germany

Despite the challenges mentioned in Section 2, there are several studies trying to draw a broad picture of the process of doctoral studies in Germany. Table 1 gives an overview of the different studies we discuss in turn with respect to their sampling strategy.

Table 1: Overview of recent studies on PhD Candidates in Germany

Authors	Year	Target Population	Sampling Strategy
Gerhardt, Briede, Meus	2005	PhD Candidates in Germany	Online access contacted through institutions and journals
Berning, Falk	2006	PhD Candidates in Bavaria	Online access contacted through institutions and journals
Senger, Vollmer	2010	PhD Candidates in 20 German universities	University registers
Hauss, Kaulisch, Zinnbauer, Tesch, Fräßdorf, Hinze, Hornbostel	2012	PhD Candidates in seven German universities	University registers
Jaksztat, Preßler, Briedis	2012	Not clearly defined	Online access panel, registers from universities of applied sciences, PhD programs, Max-Planck research Schools
Wolters, Schmiedel	2012	PhD Candidates in Germany	Step 1: sample of professors Step 2: sample of PhD Candidates
Fabian, Rehn, Brandt, Briedis	2013	PhD candidates who finished their prerequisite degree in 2001	4 th follow-up study based on a register of university graduates from 2001

Gerhardt et al. (2005) present a study on the situation of PhD candidates in Germany. A sample of doctoral candidates was realized using two different sources: First, possible institutions for doctoral candidates to obtain a degree (i.e. universities, research institutions, and businesses) were contacted and asked to forward questionnaire links and motivate their respective doctoral candidates to participate. Second, several journals and websites provided links to the questionnaire and further information about the study. Of the (roughly) estimated 100,000 doctoral candidates, 18,000 used the questionnaire link and about 10,000

finished the questionnaire itself. A basic check for external validation was conducted by comparing the distribution of fields of those participating to the distribution of those who finished their doctoral degree using the official data from the Federal Statistical Office. For most fields, the correspondence was rather high, only for law and medicine there were relatively fewer doctoral candidates than expected. In addition, the share of women who completed the questionnaire was higher than the share of women who finished their degree.

A study very similar in structure and content was conducted by Berning & Falk (2006), who concentrated on Bavaria. With a similar contact strategy as Gerhardt et al. (2005), they reached 21% of their estimated gross sample of more than 13,000 candidates. They also found that slightly more females participated compared to the expected percentage from the proposed gross sample.

One main issue with both studies is the access to those filling out the questionnaire. It is not clear whether those who answered are indeed PhD candidates, as the names of the respondents were not known to the researchers and their affiliations could not be checked. The sample selectivity may also be an issue: there is no reason to assume that the distribution of candidates' subjects should be identical to the distribution of those who obtained a doctoral degree. They could be similar, but, due to differences in time-to-degree and drop-out rates, should not be identical, which makes a comparison futile. In terms of the representativeness of the sample, clearly there may be differences between those choosing not to respond (or not receiving any hints) compared to those responding. If the ones responding are those better connected to the respective institution, for instance, they may also be more content with their PhD work, because they feel supported. In the end, the results may not reflect the situation of the general population of PhD candidates.

A slightly different approach to sampling was taken in a study by Senger & Vollmer (2010), who cooperated with 20 universities to obtain a gross sample of all doctoral candidates in the respective universities. They received lists containing the email addresses for all candidates, who were then informed by their university about the study and asked by the authors to participate in the survey. Contrary to the two previous studies, this system allowed to personalize links, such that each invitation could be answered at most once. However, even

with this increased effort to obtain a regular gross sample, the study can only estimate that around 25,000 individuals pursued a PhD at the contacted 20 universities. Of these, 3,663 (about 15%) participated in the study. The authors do not mention tests for a possible selection into the survey and do not compare gross sample distributions against those in the sample, so it remains an open question whether the results are representative for the universities under study.

Similar to Senger & Vollmer (2010), Hauss et al. (2012) sampled doctoral candidates by contacting several universities, foundations and other funding institutions first to receive registers of PhD candidates. The results presented in their paper are limited to the candidates who were affiliated to the participating universities, however. Although the contacted universities were not sampled randomly, there is no further selection of doctoral candidates, as all candidates within one university were targeted to be interviewed. Almost 3,000 out of a total of 13,400 candidates at universities were interviewed via online questionnaires. While the study does not claim to be representative of the population of doctoral candidates, still a comparison with the enrolled doctoral students in Germany (as mentioned above) as well as with the results of Wolters & Schmiedel (2012, see below) is made, displaying small differences concerning the distribution of candidates by sex and field.

Jaksztat et al. (2012) combine several studies for interviews with PhD candidates conducted in 2011. They used an online access panel of early career scientists in German universities and research institutes, from which they extracted those without a degree. The second source is early career academics at universities of applied sciences ("Fachhochschulen"), which had not been targeted before. The email addresses for these individuals were gathered from the websites of the respective institutions. A third group was directly taken from different PhD programs, which were contacted through the administrative body of the corresponding hosting institutions. Finally, the last group of PhD candidates was contacted from the International Max-Planck Research Schools via the central administration. The multitude of sample sources makes it difficult to evaluate the quality of the sample used here, especially since there is little information on the respective target populations. This may also be the reason that the study does not provide comparison with any external source.

A study by the Federal Statistical Office (Wolters & Schmiedel, 2012) is more elaborate in its design: the authors used a two-step procedure, where a sample of professors was drawn clustered on the university level in the first step. Then, based on this sample, PhD candidates of responding professors were sampled and contacted in the second step. For the first step, any participating university (some declined to provide contact information of their professors and were thus excluded) received a sampling probability inversely proportional to the number of received PhDs per professor and year, where the lowest probability was set to 1/10 and large universities receive a probability of 1 (albeit the authors do not provide a definition of “large university”). This sampling concept led to a gross sample of around 19,500 potential PhD advisors, of which 48% responded to the interview request. More than two thirds of the responding professors agreed to forward the questionnaires to their advisees, leading to almost 50,000 potential PhD candidates to interview. In the second step, a sample of slightly more than 2,000 professors was drawn, stratified by field of study and federal state, where professors with rare groups of doctoral candidates (e.g. candidates from outside the university) received a sampling probability of 1. The number of PhD candidates advised by these approximately 2,000 professors amounted to almost 20,000. The professors were then contacted again and asked to distribute the questionnaires (pen and paper, with envelope and stamp to be returned) among all of their PhD candidates. 8,700 doctoral candidates (43% of the gross sample) participated in the study, with some variation in response rates across the different federal states.

One advantage of this sample is the detailed gross sample, which allows weighting the final sample based on the characteristics of the gross sample of professors (step 1) as well as doctoral candidates (step 2). Margins used for weighting were ten study fields, volume of employment (full-/part-time), region (east/west), and sex (male/female) for the sample of professors, where these margins were obtained through a general register of professors, containing all professors at universities in Germany. For the PhD candidates, the weighting margins were obtained from a frame of doctoral candidates who were enrolled as students, using the number of candidates per professor and all gender-field-of-study combinations.

Although the study is the most advanced, the weighting cannot be called optimal, as it relies on a potentially biased sample. As mentioned above, approximately only one half of all doc-

toral candidates is enrolled as a doctoral student. If – as is likely – these enrolled candidates are substantially different to those which are not enrolled, the weighting factors provide a bias towards the characteristics in the enrolled sample. For instance, if PhD candidates in economics do not have to enroll for some reason, the field-gender combination margin would be too low for the population of all candidates, and the numbers for economic PhDs would be too low. Given the margins used, this of course will be problematic mainly when looking at the total population of candidates, not when considering differences within certain fields of study. Nevertheless, the approach used by the Federal Statistical Office can easily be regarded as the most elaborate (and probably most costly in terms of time and money) so far.

Fabian et al. (2013) use a slightly different approach in their study: instead of trying to reach doctoral candidates, they targeted individuals with a pre-doctorate degree (i.e. a Master's degree or a diploma) in 2001, when the population is clearly defined and available through a central register. From this register of university graduates, the authors specified clusters of field of study and university, from which stratified samples were drawn. The individuals were contacted in 2002/03 through their alma maters, and then received pen and paper questionnaires. Of the 33,000 questionnaires sent out, slightly more than 8,000 were returned. A second wave followed in 2006/07, and in 2011/12, a third questionnaire was sent out to the remaining 5,400 valid addresses. After the main interview, an additional online questionnaire concerning PhD candidature was implemented. The corresponding sample consisted of about 1,300 candidates, of which almost 1,000 answered. Given the sampling frame of the starting study is available the authors are able to calculate weights correcting for attrition as well as non-response based on the known characteristics. In that sense, this study can claim to be representative of a specific population, namely of those doctoral candidates who finished their basic university degree in 2001 at a German university.

4 Suggestions for sampling

As the previous section shows, there are doubts about the degree to which the results from former studies on doctoral candidates in Germany can be generalized. In the following, we discuss different strategies to draw a sample of doctoral candidates as the basis for statistical inference on the complete population of PhD candidates in Germany. In particular, we

point out issues of applicability as well as advantages and drawbacks of the respective methods. Three methods remain of which the first two have already been used in the field to some extent:

- 1) Sampling via stratified clusters based on universities and/or faculties
- 2) Sampling based on a screening approach
- 3) Network related sampling

Sampling via stratified clusters based on universities and/or faculties

This approach relies on the assumption that not all universities have to be contacted or used in the sample, but that there are strata of universities or faculties similar enough to each other on important dimensions such that drawing a clustered sample⁸ is sufficient to do inference on the target population. Most of the existing studies mentioned above use a two-step procedure to collect data because universities (and other institutions that doctoral candidates are affiliated to) can be considered to be gatekeepers for registers and contact data of PhD candidates. This circumstance will remain independent of the launch of extensive systems to register doctoral candidates at German universities. In general, one possibility is to draw a random sample on the institutional, more precisely on the faculty level⁹, as a complete list of German universities is available¹⁰, and hence a list of faculties can also be compiled. The sample could be stratified by the source of institutional funding (public versus private) as well as the main subjects a PhD can be obtained in¹¹. Clusters should at least include the federal state, but could also be extended to the size of the university or faculty and the number of PhDs awarded in a certain period of time (not necessarily a year).

In a second step, the drawn sample of universities or faculties, respectively, should be contacted asking for the provision of a list of their affiliated doctoral candidates including infor-

⁸ See, for instance, Groves et al. (2009, p. 106 ff.) or Babbie (2013, p. 215 ff.) on (stratified) multistage cluster sampling.

⁹ The classification of universities or faculties could be based on the Carnegie Classification of Institutions of Higher Education.

¹⁰ See “Hochschulen in Deutschland”, retrieved December 18, 2015 from <http://www.hochschulkompass.de/hochschulen/die-hochschulsuche.html>.

¹¹ In Germany, different titles can be obtained depending on the field of study or the focus of the faculty, respectively, such as Dr. ing. for engineers or Dr. iur. for doctors of law.

mation on their field of research, sex, age, main source of funding and employment status¹², and duration of doctoral candidature so far. In case of non-response on this (university/faculty) level, adjustments can be made according to the known characteristics of the gross sample.

As discussed above, however, up to now most German universities do not dispose of comprehensive registers of “their” doctoral candidates. Therefore, a sample of PhD candidates can currently not be based on characteristics of the target population. Even incorporating all candidates affiliated with the selected faculties relies on the exhaustive collection of contact data to make sure that the whole subpopulation is covered and a comparison of the realized sample to the characteristics of the gross population is possible. In addition, the support of the selected faculties is needed – which may be hard to achieve because administrators need to be convinced that participation does pay off (either for them directly as they get feedback on their doctoral training or as they contribute to knowledge acquisition). Hence, effort beyond the mere data collection is needed, both in terms of money and time.

Sampling based on a screening approach

One of the usual ways to sample a population with characteristics not available in a sampling frame is to pre-screen individuals before actually asking them to participate in the study (e.g. Kalton & Anderson 1986; Gabler & Häder 1997; Häder & Häder 2011). Given that the population of those trying to obtain a PhD in the complete population is rather small – estimated at about 200,400 individuals, or around 0.25% of the total population accordingly (Wolters & Schmiedel 2012, p.5; Zensus 2011) – a further selection of the population prior to the screening is absolutely necessary. The average age doctorate degrees were obtained at in 2014 is about 30 years (Statistisches Bundesamt 2015b, p. 157). The majority of people striving for a PhD are estimated to be aged 25 to 31 (Wolters & Schmiedel, p. 25). If a screening were to be based on the population register, one could cluster regions and stratify by age. However, still a large group of individuals would have to be screened to reach a reasonably sized sample of PhD candidates, as a rough estimate of about 1.5% of those in this age group

¹² Funding and the employment status are shown to have a major effect on the conditions of doctoral candidates (see Hauss et al. 2012, p. 123 ff.).

would try to receive a doctorate.¹³ Given this small percentage, within a population defined via registers, a screening process is very inefficient: for a sample of 1,000 PhD candidates, more than 66,000 individuals¹⁴ in the age group of 25 to 39 year olds would have to be screened. At the same time, there are additional hurdles: given non-contact, non-response, and measurement error when trying to classify individuals into the target group, the number of individuals actually needed in the gross sample to reach a net sample of 1,000 PhD candidates would likely be above 100,000.

Hence, screening can only follow from a different source of already selected individuals, similar to Fabian et al. (2013): those who finished their prerequisite university degree (in Germany usually a Master's degree or a diploma) can provide the basis for a random sampling procedure. While a sampling frame exists through the register at the examination offices (data on graduations are transferred to the State Offices of Statistics and the Federal Office of Statistics thereafter), contact data can only be gathered with the help of the universities where the students graduated. Directly after the qualifying degree, a screening survey stratified by field of study could identify those graduates planning to obtain a doctorate. The selected potential PhD candidates could then be followed until they drop out or finish their degree. Estimates of the Wissenschaftsrat (2011, p. 31) allow to roughly predict the required sample size needed for screening: over all fields of study, the ratio of successful PhDs from 2007-2009 to all university degrees from 2002-2004 is 19% (excluding medical degrees). If a researcher were interested in 1,000 PhD degrees, about 5,000 students with a university would have to be screened in the beginning of the study.¹⁵ Still this solution would neglect that failure rates in the context of the doctorate possibly differ between fields, which at the moment are unknown.

The screening approach outlined has the advantage that stratified random sampling is possible and the individuals can be contacted directly through the university they graduated at,

¹³ If about 17% of the German population (80.2 Mio.) are aged 25 to 39 (Zensus 2011), the share of doctoral candidates – estimated to amount to 200,400 by Wolters/Schmiedel (2012, p.5) – accounts for 1.5% within this age group.

¹⁴ The number of 66,000 individuals results from dividing 1,000 by 1.5%.

¹⁵ Of course differences by field of study would have to be taken into account, e.g. only about 11% of law, economics and sociology majors follow with a PhD, while 43% math or natural science majors finish their doctoral degree Wissenschaftsrat (2011, p. 31).

while the university (or other entities like funding institutions) where the doctorate is obtained needs not to be involved. Still this approach also bears some problems: individuals with a prerequisite university degree earned outside of Germany are not covered by the sampling frame and would be hard to include. Also, the initial screening would have to be very broad to include all possible later PhD candidates – a respective survey question should thus only try to identify those who are least likely to obtain a doctorate, leaving all others in the sample. Hence the sample would contain a rather large percentage of individuals who might never try to earn a PhD just to be sure to include all potential candidates. Restricting the sample to those who are absolutely sure that they want to obtain a doctorate leads to a smaller, more efficient sample, but would likely bias inference on PhD candidates. Either way, the major advantage of this approach is that the candidates are picked up directly after their qualifying degree and are not (yet) affiliated with their new universities. Given the characteristics of the university they graduated at, sampling could occur clustered and stratified given the suggestions above, such that weighting to account for non-responding institutions becomes possible.

Respondent-Driven Sampling

A third approach to gather information on the population of PhD candidates is sampling based on their network of other candidates.¹⁶ The basic idea when involving the networks of respondents is that sampling occurs based on repeated referrals of respondents of a specific, otherwise non-identifiable group to another person with the same characteristics of interest (e.g. “hidden populations” like drug users or HIV positive individuals). Goodman (1961) defined the approach: an initial random set of respondents in the target population is contacted and asked to participate in an interview. They are then asked to provide contact information of a fixed number of other people in the same target group, who are subsequently contacted by the researcher. Each member of this group is then asked to name other individuals, until the previously determined number of “stages” has been reached. The applicability of this approach, also termed snowball sampling, relies heavily on the randomness of the initial individuals – if they are not a truly random selection of the group of interest, the whole sample may be biased towards the characteristics of this group.

¹⁶ On an overview of network sampling see Baker et al. (2013, p. 49ff.), for instance.

Heckathorn (1997) proposes a similar approach which is (at least theoretically) unbiased, the so-called respondent-driven sampling (RDS). Here, initial respondents (“seeds”) are found and given an incentive for the interview (primary incentive). As in snowball sampling, each seed recruits a fixed number of targets from the hard-to-sample group. This process is repeated over a number of “waves” as the recruited themselves become recruiters. For the recruitment, an additional incentive (secondary incentive) is offered to the seeds, which they receive for every successful interview conducted with a person they addressed. Tracing of the recruitment is important for the process, and can be achieved via numbered coupons tracking the origin of each respondent. The other key variable is a precise estimate of each participant’s network size. Heckathorn (1997) develops two theorems: the first theorem states that after a finite number of iterations there is a wave, at which the sample composition has converged to that of the target population and is thus independent from the initial seed(s); the second states that the convergence to such an equilibrium is reached quickly (i.e. at a geometric rate).

Additionally, Wejnert & Heckathorn (2008) provide five key assumptions to hold for a successful implementation of RDS:

- 1) Respondents must be recruited under the assumption of reciprocity, i.e. if person A recruits person B, in principle B could also have recruited A.
- 2) A connection between all persons within a network must be possible.
- 3) In principle, any person could be recruited a second (or further) time.
- 4) Respondents are able to identify their network size.
- 5) Respondents randomly choose recruitments from their network.

Considering the example of PhD candidates, it seems that assumptions 1, 3, and 4 are met. There are no “one-way” relations that prohibit a reverse recruitment (assumption 1); participation does not rule out being recruited a second time (assumption 3); and doctoral candidates should be able to count the number of other doctoral candidates they know (assumption 4). The second assumption, however, is likely to be violated for the complete population of PhD candidates in Germany: even within one university, there are not necessarily connections between, say, physicists and sociologists. Here, the definition of “network” plays a crucial role: within all PhD candidates in a certain research field, a connection is like-

ly, hence defining a network on the basis of field of study and university may yield a positive evaluation of assumption 2. Schonlau & Liebau (2012), who mainly provide a Stata module for RDS sampling, mention that assumption 5 is generally doubtful, as respondents may have certain preferences which can bias the results. In the setting of PhD candidates, this problem may arise if, for example, the seeds are more likely to recruit doctoral candidates in their cohort. Here the initial recruitment may provide a solution – if it is possible to stratify the seeds according to some basic characteristics, the issues regarding assumption 5 may be less severe.

Wejnert & Heckathorn (2008) also extend the RDS approach to an online setting, where seeds are recruited via email, which subsequently use emails themselves to recruit further participants. Given that emails are virtually universal this approach may be used for the PhD setting in Germany as well. As emails are sent quicker than personal contact is made, a higher number of waves could be approached in shorter amounts of time. However, identification becomes an issue, when respondents try to recruit themselves to receive more incentives – a challenge not present in RDS done by face-to-face interviews. Also, the payment of incentives leads to expenses that may be prohibitively high. In their study, Wejnert & Heckathorn (2008) issue a primary payment of \$10 for each respondent plus a secondary \$15 for each recruit. Payment and recruitment are also associated with a considerable administrative effort, as the recruited individuals need to be instructed how to recruit the next wave and payments need to be wired individually. This holds true for the email solution, in particular.

Conclusion

Up to now, we know only little about the situation of doctoral candidates in Germany. Since a comprehensive and consistent register of PhD candidates does not exist yet and thus the distribution of crucial characteristics like sex, age or field of study are unknown, a random sample cannot be drawn. Consequently, sound statistical inference on the population of doctoral candidates in Germany cannot be made.

In this paper, we suggest three alternative approaches to collect generalizable data on doctoral candidates, namely sampling via stratified clusters based on universities or faculties,

sampling based on screening as well as network related sampling. We outlined several advantages and disadvantages of either approach which have to be considered against the background of a particular research question and study setting including financial resources and time budget.

In the absence of a central register, there can only be second best solutions to create a representative sample of doctoral candidates in Germany. If we were to suggest, we would use a combination of clusters of faculties stratified by subject, where a small number of seeds are drawn randomly to recruit further participants based on a respondent driven sampling approach.

However, some progress is made as the new version of the Hochschulstatistikgesetz includes regulations concerning the data collection on doctoral candidatures. Given the high political demand to assess the quality of doctoral education in Germany, this can be considered as a breakthrough towards an advanced analysis of the situation of doctoral candidates. Nevertheless, until such a register has been comprehensively institutionalized, research on doctoral candidates must remain cautious with respect to the sampling procedures used and the conclusions drawn from currently available data.

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