# Determinants of PhD holders' use of social networking sites: An analysis based on LinkedIn

Stefano H. Baruffaldi[a], Giorgio Di Maio[b,*], Paolo Landoni[c]

[a] École Polytechnique Fédérale de Lausanne – CEMI, Switzerland
[b] Politecnico di Milano, Department of Management, Economics and Industrial Engineering, Italy
[c] Politecnico di Torino, Department of Management and Production Engineering, Italy

## ABSTRACT

Social networking sites are an increasingly important tool for career development, especially for highly skilled individuals. Moreover, they may constitute valuable sources of data for scholars and policy makers. However, little research has been conducted on the use by highly skilled individuals of those social networks. In this paper, we focus on PhD graduates, who play an important role in the innovation process and in particular in knowledge creation and diffusion. We seek to increase understanding of the determinants that induce PhD graduates to register on LinkedIn and to develop wider or narrower networks. Controlling for the most relevant individual characteristics, we find that (i) PhD holders moving to the industry sector are more likely to have a LinkedIn account and to have a larger network of connections in LinkedIn; (ii) PhD holders are more likely to use LinkedIn if they have co-authors abroad; and (iii) they have wider networks if they have moved abroad after obtaining their PhD. In light of our analyses, we discuss the usefulness of – and main concerns about – the adoption of LinkedIn as a new data source for research and innovation studies.

© 2017 Elsevier B.V. All rights reserved.

## 1. Introduction

Today, the routine practices of everyday life have incorporated Internet services and social networking sites (SNSs). Among other aspects, the spread of the Internet has had a great impact on professional lives. This is due to the pivotal role of information in labor markets (Autor, 2001) and in the development of professional networks. In particular, the Internet may have important implications for the careers of highly skilled individuals (Acemoglu, 1998; Cairncross, 2001; Varian, 2010). Not surprisingly, the use of the Internet is significantly more widespread among highly skilled workers than among low-skilled ones. However, little research has been conducted on how highly skilled individuals use Internet applications and, in particular, SNSs.

Some studies provide evidence on the effect of the diffusion of broadband infrastructure on employment at an aggregated level (see for instance Czernich, 2014). Other evidence suggests that Internet-based technologies are effectively adopted in order to establish collaborations and networks at greater geographical dis-

tances among universities and firms (Ding et al., 2010; Forman and van Zeebroeck, 2012; Hoekman et al., 2010). Few authors have investigated the use of specific Internet platforms. As noted by Zide et al., "most of the empirical research on SNSs [. . .] has focused on Facebook", a non-professional site, even when studying recruitment processes (Zide et al., 2014). Finally, in academia, some studies have demonstrated that a large number of researchers increasingly make strategic use of Internet-based tools (emails, personal web pages, SNSs) to coordinate team activities, promote their competences and professional profiles, disseminate scientific results and establish new connections (Bar-Ilan et al., 2012; Barjak, 2006a; Barjak et al., 2007; Mas-Bleda and Aguillo, 2013; Walsh et al., 2000; Ward et al., 2015; Winkler et al., 2010).

In this work, we contribute to knowledge on this topic by analyzing the use of LinkedIn's SNS by PhD holders graduated from two European institutions: the Politecnico of Milan in Italy, and the École Polytechnique Fédérale de Lausanne in Switzerland.

We focus on PhD holders, given their high level of qualification, and their importance in the creation and transfer of knowledge (Casey, 2009; Stephan, 2012). PhD holders play an important role in the innovation process, in pure and applied research, and especially in the transfer and diffusion of knowledge (Herrera et al., 2010; Zellner, 2003) and its economic exploitation (Agrawal, 2006; Herrera and Nieto, 2015). The number of students awarded a doc-

* Corresponding author.
E-mail addresses: stefano.baruffaldi@epfl.ch (S.H. Baruffaldi), giorgio.dimaio@mail.polimi.it (G. Di Maio), paolo.landoni@polito.it (P. Landoni).

torate each year has increased greatly worldwide in recent years (Bloch et al., 2015), and the job searching strategies of younger generations are changing nature thanks to the Internet-based technologies (Smith, 2015). Consequently, understanding how SNSs are adopted by PhD holders, and how they influence their professional trajectories, has implications for the debate on the modes of creation and transfer of knowledge. Furthermore, insights on the dynamics of this emerging digital environment can help policy-makers to develop adequate policy responses.

Specifically, we intend to shed light on the actual use of SNSs by PhD holders by analyzing the determinants that correlate with PhD holders' probability of registering on LinkedIn and developing wider networks. We focus on three potential determinants for the use of LinkedIn: sector mobility (from academia to industry), international mobility, and professional collaborations (measured with the number of co-authors in scientific publications). Indeed, not all PhD holders – like not all professionals – are registered on LinkedIn, and those that have an account on this SNS do not have the same numbers of "connections": whereas some are connected only with their closest colleagues, others have a network with hundreds or even thousands of connections.

As noted by Burke et al., studies on SNSs "generally differentiate their use based on motivations, rather than actual behavior. This focus on motivation occurs in part because fine-grained behavioral data are not available, while survey measures of users' attitudes are easy to collect" (Burke et al., 2011). Our study focuses on fine-grained behavioral data instead of users' declared motivations. We have used university data, curricula vitae, the Scopus database, and LinkedIn data to create a novel dataset on PhD holders' behavior during and after graduation.

Using this unique dataset, our study contributes to the literature in two ways. On the one hand, we test simple hypotheses on the determinants of social networking site presence and its extent for PhD holders. On the other hand, in light of our analyses and results, we discuss the value and the limits of LinkedIn as a new data source for research on highly skilled workers. For instance, LinkedIn may provide important data with which to solve the important policy problem of PhD holder employment caused by the limited number of opportunities in academia and the mismatch between PhD holders' skills and expectations and the needs of industry (Huisman et al., 2002; Mangematin, 2000; McAlpine and Emmioğlu, 2015; Nogueira et al., 2015; van der Weijden et al., 2016; Wendler et al., 2012).

The paper is organized as follows. Section 2 contains the literature review and presents the research hypotheses. Section 3 explains the data and the methodology used. Section 4 describes the results. Section 5 discusses the results obtained and concludes.

## 2. Literature review and hypotheses

The importance of social networks is widely acknowledged. A person's location in social networks determines the type of positions to which s/he has access. Consequently, social networks determine the way in which the positions with the best rewards are assigned (Granovetter, 1990; Lin and Dumin, 1986). Moreover, the social and economic resources, actual or potential, that a person can access depend on the social network to which s/he belongs, the location that s/he occupies within it, and the number, character and strength of the ties that s/he maintains: social networks increasingly shape people's work lives (Bourdieu, 1986; Burke et al., 2011; Granovetter, 1990; Lin and Dumin, 1986).

SNSs make it possible to expand one's social network beyond one's initial position by establishing or maintaining connections with people that would be otherwise unreachable due to institutional or geographical constraints. Expanding one's social network

is more than just delivering information about oneself; it entails interactions with which to corroborate the information exchanged.

Information plays a crucial role in career decisions and professional collaborations, especially for highly skilled workers (Montgomery, 1991; Pezzoni et al., 2012; Ponzo and Scoppa, 2010). Owing to the existence of significant information asymmetries, highly skilled workers need to signal quality and competences in a given domain, to screen the characteristics of potential employers or collaborators, and to exchange information with existing collaborators. Long before the existence of the Internet, economists and sociologists questioned the relative importance of formalized and codified sources of information (e.g. curricula vitae) and informal channels (e.g. referrals and personal social networks). On the one hand, qualifications and formalized sources are necessary; on the other, an individual's access to additional information, and its validation, is contingent upon his/her social position, as well as on the nature of informal social ties. Accordingly, social capital, defined by Bourdieu as "the aggregate of the actual or potential resources which are linked to a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu, 1986, p. 248), is fundamental.

The Internet, and in particular SNSs, have implications for both channels (Atasoy, 2013; Autor, 2001; DiMaggio and Bonikowski, 2008). First, they make it possible to communicate formalized information (e.g. personal profiles) at any geographic distance, and potentially without intentional transactions. Second, they make it possible to maintain contacts and create new ones (e.g. through the system of connections). Notably, SNSs provide such services for free, thus lowering the costs of these information exchanges to their historic minimum.

However, some authors have noted that costs in the use of such tools still persist in the form of the time spent on using them (Brynjolfsson and Oh, 2012; Greenwood and Kopecky, 2013).

In what follows, for each of the professional factors of interest (sector mobility, international mobility, and international collaborations) we first present the literature that has discussed their determinants and consequences, and then outline our hypotheses on their expected relation with the use of SNSs.

### 2.1. Researchers and sector mobility

The literature on the sector mobility of PhD holders has focused on the factors that induce them to move to the private or public sector outside academia. It finds that both individual characteristics and scientific fields are important, besides the scarcity of available positions in the university sector (Bloch et al., 2015; Herrera and Nieto, 2015; Mangematin, 2000). PhD holders with previous experience in the private sector, who have collaborated with private firms during their studies, whose research has a commercial potential, or who have valuable patents are more likely to move to the private sector or to become entrepreneurs (Crespi et al., 2007; Fritsch and Krabel, 2012).

In particular, Crespi et al., on analyzing determinants of mobility from academia to business, found the presence of a strong effect of seniority on mobility, while they found no impact of scientific productivity (Crespi et al., 2007).

PhD students are divided equally between those who want to move to the private sector and those who want to remain in academia. The latter are more committed to publishing and less interested in economic factors, thus demonstrating a greater "taste for science" (Mangematin, 2000; Roach and Sauermann, 2010).

Because PhD holders are aware of the limited career opportunities in academia, they consider a professional career in the private sector to be one of the possible outcomes of their educational investment. Once they have moved into the private sector,

they rarely move back to the academic one (Cruz-Castro and Sanz-Menéndez, 2005).

PhD holders are accustomed to using the Internet and SNSs; but this does not imply that they are prepared to use them to support their careers. There are very few specific PhD classes related to career preparation, and the use of SNSs to support career preparation is very rare (Collins et al., 2012).

### 2.2. PhD holders' sector mobility and LinkedIn

We assume that the adoption of LinkedIn, and the number of connections within it, of PhD holders is primarily related with their professional career choices. We consider the decision to move to industry rather than continue the academic career. The decision to move to industry may affect the probability of LinkedIn use because PhD holders usually lack a network of relations with business and are interested in building a social network using LinkedIn for self-promotion, and to acquire information on the available job offers and the characteristics of employers. On the other hand, PhD holders who continue their academic careers can rely largely on alternative mechanisms to access and disclose information, such as personal professional networks or face-to-face meetings at conferences. Moreover, in academia, the quality of a scholar is mainly evaluated by his/her articles, i.e. the number of his/her publications and the citations received (Siow, 1991).

The expectation that PhD holders moving to the business sector are more likely to have a LinkedIn account may seem straightforward. However, to the best of our knowledge, it has not yet been addressed in the literature, and no evidence has been provided on the matter.

PhD holders can rely on other, traditional, services. Or they can exploit their existing social networks built in academia or elsewhere, and not use a SNS. Secondly, because of the shortage of academic positions in relation to the number of new PhD holders (Mangematin, 2000; Martin-Rovet, 2003), even those PhD holders who aspire to an academic career may use LinkedIn to build a social network: the latter could prove useful if they are forced to seek employment in the business sector. In general, it is not obvious *a priori* that PhD holders moving to industry are more likely to use LinkedIn than PhD holders remaining in academia.

For these reasons, we advance and test the following hypothesis:

**H1a.** PhD holders moving to the industry sector are more likely to have a LinkedIn account

Moving to industry coincides with entry into new professional networks and communities. By contrast, mobility within academia more often takes place through existing professional networks and is more likely to lead to the creation of redundant connections. Therefore, PhD holders who switch to industry will have stronger incentives to actively maintain and exploit their existing social network in order to establish new professional connections. In short, PhD holders moving to industry will try to expand their social networks and will have a higher propensity to use SNSs to manage their connections. Therefore, we formulate the following hypothesis:

**H1b.** PhD holders moving to the industry sector have larger networks of connections in LinkedIn

### 2.3. Researchers and international mobility

International mobility has always characterized scientists' careers (Gaillard and Gaillard, 1997). However, the initial movement from Europe to the USA, and later from less developed to more developed countries, was generally a permanent transition driven by economic determinants. This led to scientific mobility being likened to the general migrations of highly skilled workers

(Brandi, 2001). Today, migration flows involve an increasing number of countries in a new context characterized by new models of international scientific collaboration (Gaillard and Gaillard, 1997). The globalization of scientific research and the academic sector increases the international mobility of scientists among different categories of highly skilled workers (Altbach and Knight, 2007; Chan and Dimmock, 2008; Freeman, 2010; Lauring and Selmer, 2010; Mahroum, 2000b; Qiang, 2003; Rostan and Ceravolo, 2015). This comes about in a context of expanding higher education worldwide, growing numbers of international students, and increasing international collaborations (Freeman, 2010). In this new context, the majority of movements are not definitive but temporary, and they involve multiple destinations (Newland, 2009). However, a considerable number of researchers will not return to their country of origin (Van Bouwel, 2010), and temporary movements can become permanent (Baláz et al., 2004).

Economic needs may still motivate the international mobility of scientists (Golub, 2002; Mahoney, 1979) when basic economic opportunities are lacking in the country of origin, or, in the case of return mobility, when economic growth in the country of origin is significant compared to that of the host country (Borjas and Bratsberg, 1996; Khoo et al., 2008). Similarly, personal or family reasons and constraints may also explain the international mobility decisions of scientists (Baláz et al., 2004; Dustmann and Weiss, 2007).

However, researchers' mobility is often more strongly related to specific professional considerations (Baruffaldi and Landoni, 2016; Mahoney, 1979; Mahroum, 2000a; Merton, 1973; Salt, 1997) such as: independence and level of responsibility (Azoulay et al., 2011; Roach and Sauermann, 2010; Sauermann and Cohen, 2010), and better opportunities to advance their careers, exchange ideas and broaden their knowledge (Gaillard and Gaillard, 1998; Grubel and Scott, 1966; Mahroum, 2000b; Meyer, 2003). In many cases, researchers move abroad within the context of an international community in order to create and maintain international knowledge networks (Jöns, 2009; Mahroum, 2000a; Trippl, 2013), or sometimes because they are participating in specific programs (Ota and Watanabe, 2007).

### 2.4. PhD holders' international mobility and LinkedIn

As said, LinkedIn is a tool that allows professional self-promotion where a person can disclose positive information about him/herself and signal quality. Personal networks and face-to-face contacts are the main alternative mechanisms with which to attain the same objective within academia or in order to move to industry.

As noted by several authors, personal networks have great importance as sources of information on employment opportunities. The large majority of workers have found their jobs through these networks, and firms use employee referrals to fill job vacancies for many reasons, among them adverse selection in the labor market (Greenwald, 1986; Ioannides and Loury, 2004; Montgomery, 1991; Ponzo and Scoppa, 2010).

Geographic proximity alone also facilitates the creation of new and purposeful connections by enabling, whenever necessary, face-to-face meetings. SNSs are tools able to overcome, to a certain extent, geographic boundaries and information asymmetries (Autor, 2001; Varian, 2010).

Researchers move internationally mainly within international knowledge networks (Ackers, 2005; Mahroum, 2000a,b; Franzoni et al., 2014; Scellato et al., 2015). Based on these considerations, we expect that PhD holders who move internationally to new countries are more likely to adopt SNSs to remain in contact with their previous colleagues and to start connecting with new ones:

**H2a.**  PhD holders moving to a country different from the one where they obtained their PhD are more likely to have a LinkedIn account

Again, similarly, and with arguments analogous to those applying to sectoral mobility, international mobility will more likely coincide with the expansion of the professional networks of PhD holders. Notably, PhD holders moving internationally may also use SNSs more extensively in order to keep in contact with connections developed where they obtained their PhD.

**H2b.**  PhD holders moving to a country different from the one where they obtained their PhD have larger networks of connections in LinkedIn

### 2.5.  Researchers and international collaborations

Collaboration is a further crucial factor characterizing scientific and research activities. As noted by Beaver et al., collaboration "originated, developed, and continues to be practiced as a response to the professionalization of science" (Beaver and Rosen, 1978). The increasing level of quality required for publication in high impact journals, opportunities to use and share the costs of large scientific infrastructures, and the increasing breadth of data adopted, among other factors, have driven an increase in collaboration across institutional and national boundaries (Jonsen et al., 2013; Zhou and Lv, 2015). Using co-authorship as an indicator of international collaboration, several studies have found a significant increase in the number of collaborations over time, particularly across national borders (Hoekman et al., 2010; Leydesdorff and Wagner, 2008). Co-authored papers receive a higher number of citations, which generally increase with the number of co-authors. Moreover, articles published through international collaborations achieve higher impact than those published through domestic collaborations (Katz and Martin, 1997; Ronda-Pupo et al., 2015). While this evidence certainly reflects a difference in the quality of research, international research collaborations appear to benefit from a sort of "bonus effect" simply because they are international (Kato and Ando, 2013).

If international collaborations reward authors and increase their academic excellence, this in turn, in a virtuous circle, enables them to increase international collaborations (Abramo et al., 2011; Jeong et al., 2014). Conversely, those who do not collaborate internationally may suffer from some sort of "accumulative disadvantage" in terms of both resources and prestige (Kwiek, 2015).

The development of international research collaborations depends on the characteristics of individual institutions and researchers, and in particular on their disciplines (Rostan and Ceravolo, 2015), as well as cultural, political and geographical factors (Zhou and Lv, 2015).

International collaborations are mainly initiated by individual researchers on the basis of their interests and objectives (Leydesdorff and Wagner, 2008; Wagner and Leydesdorff, 2005).

Initiatives by individual researchers lead to the development of a network of international collaborations that is extremely dynamic. It takes the form of a system that is self-organized, often regardless of national research systems but with effects on them, and influences the organization of science globally (Leydesdorff and Wagner, 2008; Wagner and Leydesdorff, 2005). In this context, SNSs may have an "equalizing force" (Ding et al., 2010) because they provide opportunities for international collaboration to researchers on the margins of the academic community. It is noteworthy that access to the Internet and equality of access to online sources per se do not have this equalizing effect, as found by Barjak (2006b).

### 2.6.  PhD holders' international collaborations and LinkedIn

PhD holders, besides specific research networks such as Research Gate and Academia.edu, may use LinkedIn to disseminate their research's results, to promote themselves and their networks, and to manage their academic collaborations. They may also be interested in showing, inside and outside academia, the extent of their networks and their role in society as one of the means to achieve the independence and autonomy that they need (Martin-Rovet, 2003). Moreover, linkages with companies and applied research have been shown to be of interest to many academic researchers (Calderini et al., 2009; Thorn and Holm-Nielsen, 2008). One factor driving this use of SNSs may be the number of international professional academic relationships that they have developed over time.

Indeed, the development of international professional academic collaborations demonstrates the capacity to look beyond a small circle of collaborations and in many cases the importance of the research results obtained (Baruffaldi and Landoni, 2012, 2016; Horta et al., 2010). Furthermore, PhDs with academic international collaborations may be interested in showing them to their network and may be interested in having a tool with which to keep and manage these contacts. Therefore, we relate the number of international academic collaborators with which a PhD holder collaborated during the PhD, in terms of international co-authors, to the adoption and number of connections within LinkedIn. We expect that PhD holders who have collaborated with a higher number of international co-authors will have a greater propensity to adopt SNSs. Consequently:

**H3a.**  PhD holders with larger international networks of co-authors are more likely to have a LinkedIn account

Collaborations abroad, compared to local collaborations, are likely to have a larger impact on both the adoption and the number of connections in LinkedIn. This is because international networks more likely lead to new connections in different communities.

Similarly, a higher number of international co-authors more likely corresponds to a higher number of different communities to which a PhD holder can belong. Therefore:

**H3b.**  PhD holders with larger international networks of co-authors have larger networks of connections in LinkedIn

## 3.  Data and method

### 3.1.  LinkedIn

LinkedIn is the most popular SNS among highly-cited researchers (Mas-Bleda et al., 2014), and, according to the data provided by LinkedIn Corporation, it is the world's largest professional network on the Internet with more than 364 million members in over 200 countries and territories (LinkedIn Corporation, 2015).

Besides LinkedIn, among the SNSs most used in academia are ResearchGate and Academia.edu. However, these two SNSs are almost only for academic researchers. They have smaller audiences and therefore are only aimed at collaborations and networking among researchers and their institutions (Ortega, 2015; Williams and Woodacre, 2016).

Through LinkedIn, members are able to create, manage and share their professional profile online, and build and engage with their professional network (LinkedIn Corporation, 2011). Researchers can of course use LinkedIn, in addition or alternatively to other SNSs, to build their professional network with their peers in both academia and firms. Indeed, some studies have begun to analyze the relationships among LinkedIn, other social platforms,

and the academic environment (e.g. Orduña-Malea and Ontalba-Ruipérez, 2013).

LinkedIn is mainly used for professional self-promotion (van Dijck, 2013), and it is preferred by high-mobility job-seekers (Kasper, 2014). Firms consider LinkedIn to be more effective than Facebook in the recruitment process (Nikolaou, 2014), and they can use this professional SNS to reach and attract a great number of qualified active and passive job-seekers worldwide (Bonsón and Bednárová, 2013). LinkedIn, like other social media, is a suitable means to find candidates for vacant positions requiring high academic qualifications (Klier et al., 2015).

Therefore, LinkedIn appears to be the SNS preferred by highly skilled professionals wanting to build a social network in order to improve their social capital.

LinkedIn, and similar online platforms, provide a variety of personal data on a growing number of individuals: personal information, professional and personal networks, skills, personal attitudes and opinions, etc. These data sources have a great potential for research in social sciences (Kitchin, 2014). Nonetheless, a series of limitations and concerns need to be taken into account. First, individuals self-select themselves. This may cause selection bias whenever the data, if based exclusively on these sources, do not allow control to be made for the selection process. Second, most of the information is subjective or self-reported. Both these issues are common concerns also in other methods of data collection, particularly surveys (Fowler, 2013). However, these networks are frequently used as tools for self-promotion. This exacerbates the above problems because individuals choose strategically whether to use these tools, maximize their credentials, and may omit or even alter information in an attempt to deceive readers of their profiles (Bremner and Phung, 2015; Guillory and Hancock, 2012). At the same time, deception practices may ultimately result in problems, waste of time and loss of reputation. We further discuss these issues in the following sections in regard to the specific case of our study.

## 3.2. Data

We constructed a unique database combining information from multiple sources. Data were gathered and merged in 2014. Table 1 reports the list of variables and data sources for each variable in our analyses. We adopted data provided by Politecnico di Milano and École Polytechnique Fédérale de Lausanne (EPFL) on the PhD holders who had completed their PhD at the two universities, focusing on engineering faculties (in Table 1 we refer to this source as "Main data").

This context of analysis presents several advantages. First, PhD graduates in engineering, more than those in other subjects, have the option of pursuing a career and applying their specialized competences in industry rather than in academia. Second, we selected two world-ranked engineering schools comparable to several other renowned universities for size, scientific excellence and international reputation. However, and third, they also present substantial differences between each other; in particular, in terms of level of internationalization, organizational structures, and the economic systems in which they are embedded. For these reasons, we considered this context of analysis suitable for our research questions, and the results obtained are more likely to be generalizable to other contexts. The possibility to access the necessary main demographic data of PhD graduates also determined the decision to select specifically these two institutions: Politecnico di Milano and EPFL.

We had access to similar information from both universities. It included personal information, such as name, surname, year of birth, citizenship, gender, and information related to the PhD, including the matriculation date, department, section, area, closing career date. We had complete information on the cohorts of students who completed their PhDs in 2008. Hence, we obtained an initial sample of 217 PoliMi PhD holders and 328 EPFL PhD holders, for a total of 535 PhD holders.

In order to obtain information on scientific productivity, we searched for the PhD holders on Scopus Database. We gathered all the information on their publications available in the database, including the number of citations received over time. The choice of counting publications in a web-based bibliographical database like Scopus Database or Web of Science is common in the literature, and it has several advantages (Baruffaldi et al., 2016; Ding et al., 2010). First, it avoids the double counting of different versions of the same document. Second, it guarantees a certain minimum quality threshold in the publications and citations counted. The latter consideration is more valid for certain fields, such as hard sciences and engineering; it therefore applies to our context of analysis. It would be less correct in fields such as the humanities, where, for instance, books and monographs constitute an important output and are less well represented in the Scopus Database. In general, valuable publications of different kinds may not be included in the Scopus Database, but it would be difficult to select and collect them systematically.

To compute variables on the mobility of PhD holders, we manually searched the Internet for their curricula vitae. We obtained the information regarding the PhD holders' situation in 2014: in particular, the country of residence, the university or industry where they were working, the position held, and the year of any movement to another institution or country. We complemented these data with information from LinkedIn only when necessary. Finally, we manually verified whether each PhD holder had a LinkedIn account, and for those students with a LinkedIn account, we collected the information concerning their number of connections. The number of LinkedIn connections serves as an indicator of the extent to which PhD graduates exploit LinkedIn to maintain and expand professional networks. Importantly, one may want to control for the quality of the connections or, similarly, for the intensity of interaction with the individuals in the network. This can be done by exploiting information on the individuals in the network. Unfortunately, this is not feasible within the context of our study.

In order to limit concerns related with the problem of self-reporting in LinkedIn profiles, to the extent that it was possible, we relied on other sources to construct our variables. The variables built from LinkedIn data were those relatively more objective and less liable – though still not immune – to misreporting: existence of a LinkedIn account, number of connections on LinkedIn, and professional situation in terms of having a position in academia or industry. Whenever possible, we compared LinkedIn information with the information reported in personal CV documents and publication records in order to identify and resolve inconsistencies.

We were eventually able to collect complete information thanks to the curricula vitae found on LinkedIn or on the web in general and the Scopus Database, of 170 PoliMi PhD holders and 252 EPFL PhD holders, for a total of 422 PhD holders.

The number of observations necessarily diminished due to a certain number of students for whom it was not possible to find updated CV information online. In particular, we retained about 76% of observations from the Politecnico di Milano and 78% from EPFL. These percentages are similar to, and in general higher than, those obtained in similar studies based on CV information (Conti and Visentin, 2015). We were able to compare our final sample and the sample of observations that drop out based on few main control variables available in the main data source. Not surprisingly, we find some differences, which however are difficult to interpret.[1]

---

[1] The difference between the percentages of CVs found in the two institutions (76% and 78%) was not statistically significant. We found that foreign students were more highly represented in the drop-out sample (47%) compared to our final sample

**Table 1**
Variables description.

| Variable | Description | Source |
|---|---|---|
| LinkedIn account | Equal to 1 if the PhD holder had a LinkedIn account | LinkedIn |
| LinkedIn connections | Number of connections on LinkedIn | LinkedIn |
| Female | Equal to 0 if the researcher was male, equal to 1 if female. | Main Data |
| Age | Age of the PhD holder in 2008. | Main Data |
| Time for PhD | Number of years taken to complete the PhD | Main Data |
| Publications | Number of publications 1 year after the completion of the PhD | SCOPUS |
| Citations | Number of citations per paper received up to one year after the PhD | SCOPUS |
| To industry | Equal to 1 if the PhD holder moved to industry at any time after the completion of the PhD | CV and LinkedIn |
| National – in home country | Equal to 1 if the individual considered was not foreign (Italian for PhD holders from Politecnico of Milan and Swiss for PhD holders at EPFL) and had not moved abroad | Main Data, CV and LinkedIn |
| National – abroad | Equal to 1 if the individual considered was not foreign and had not moved abroad. | Main Data, CV and LinkedIn |
| Foreign – in host country | Equal to 1 if the individual considered was foreign and had not moved out of the host country. | Main Data, CV and LinkedIn |
| Foreign – in home country | Equal to 1 if the individual considered was foreign and had moved back to her/his country of origin. | Main Data, CV and LinkedIn |
| Foreign – in third country | Equal to 1 if the individual considered was foreign and had moved abroad to a country different from her/his country of origin. | Main Data, CV and LinkedIn |
| Co-authors local | Number of different co-authors affiliated with a local institution (Italian for PhD holders from Politecnico di Milano and Swiss for PhD holders from EPFL) | SCOPUS |
| Co-authors international | Number of co-authors affiliated with a foreign institution. | SCOPUS |
| Department dummies | A series of dummy variables, one for each group of students either from Politecnico di Milano or EPFL and who had obtained the PhD in different research areas. | Main Data |

We may reasonably assume that the probability of having and using a LinkedIn account is always positively correlated with the probability of providing CV information online. If this is the case, the coefficients in our analyses may have been biased towards zero but would remain correct in terms of sign.[2] However, this is mere speculation. In general, the presence and direction of this specific selection-bias remains a concern that we cannot fully address since it was not possible to construct most of our variables of interest for the sample of PhD graduates that did not provide CV information online.[3]

We report in Table 2 descriptive statistics for all the main variables in our sample. The majority of PhD graduates had a LinkedIn account (85%), and on average they had 203 connections in LinkedIn. To be noted is that the maximum number of connections reported by LinkedIn is 500. However, in our sample only 34 observations reached this upper limit. Females represented 20% of the sample. The average age at the moment of completion of the PhD was 30.3 years and the time taken to obtain the PhD was on average 4.55 years. One year after the PhD, graduates had on average 3.6 publications and 11.3 citations per paper (the number of citations was higher and equal to 16.1 for PhD graduates with at least one publication). Roughly, half of the sample had moved out of academia. The majority of the PhD graduates were nationals who had remained in their country after the PhD (46%); 14%

**Table 2**
Variables descriptive statistics.

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| LinkedIn account | 422 | 0.848 | 0.359 | 0 | 1 |
| LinkedIn connections | 358 | 202.9 | 147.0 | 1 | 500 |
| Female | 422 | 0.213 | 0.410 | 0 | 1 |
| Age | 422 | 30.32 | 2.795 | 30 | 52 |
| Time for PhD | 422 | 3.552 | 1.066 | 0 | 7 |
| Publications | 422 | 3.628 | 5.508 | 0 | 51 |
| Citations | 422 | 11.35 | 24.23 | 0 | 319 |
| To industry | 422 | 0.479 | 0.500 | 0 | 1 |
| National – in home country | 422 | 0.457 | 0.498 | 0 | 1 |
| National – abroad | 422 | 0.142 | 0.350 | 0 | 1 |
| Foreign – in host country | 422 | 0.201 | 0.402 | 0 | 1 |
| Foreign – in home country | 422 | 0.081 | 0.272 | 0 | 1 |
| Foreign – in third country | 422 | 0.118 | 0.324 | 0 | 1 |
| Coauthors local | 422 | 5.424 | 7.074 | 0 | 62 |
| Coauthors abroad | 422 | 2.640 | 5.609 | 0 | 41 |

were nationals who had moved abroad; 20% were foreign-born who had remained in the host country; 8% were foreign-born who had returned to their countries of origin; and 12% were foreign-born who had moved to a third country. Finally, the average number of coauthors within the host country and abroad was 4.4 and 2.6 respectively (7.7 and 3.7 among PhD graduates with at least one publication).

## 4. Model

The purpose of our empirical model was to study the likelihood of a PhD graduate having a LinkedIn account and the number of connections in LinkedIn as a function of his/her characteristics. Importantly, we observed the number of LinkedIn connections only for PhD graduates who had a LinkedIn account. Given the above discussion on LinkedIn data, failing to take account of the selection process of PhD graduates into the sample of individuals with a LinkedIn account would lead, in general, to selection-bias in the analysis on the number of LinkedIn connections. By way of example, assume that the propensity of individuals to have connections on LinkedIn is the same regardless of their nationality, but that foreign students with a high propensity to have connections are more

likely to have a LinkedIn account; in this case, the OLS estimate would be positive for foreign students whereas it should be zero.

For this reason, we estimated a two-equation Heckman selection model, which allowed account to be taken of the selection into the sample of individuals with a LinkedIn account based on observable variables. In the first equation, we studied the probability of a PhD holder having a LinkedIn account. In the second equation, we studied the number of the PhD holder's connections in LinkedIn. Table 1 reports the list of variables adopted. Finally, we adopted a robust standard errors estimation method. The two dependent variables were *LinkedIn account* and *LinkedIn connections* for the first and second equation respectively.

A correct specification of the Hackman selection model requires that all variables included in the second stage equation be also included in the selection equation, so that the list of variables for both dependent variables is the same.[4] We considered as first control variables the PhD holder's gender and age, and the time when s/he obtained the PhD. We then controlled for the PhD holder's number of scientific publications up to one year after the end of the PhD as a measure of her/his scientific productivity during his/her studies. In addition, we included the number of citations per paper received within the same period as a measure of quality.[5] Variables that could be approximately considered continuous (number of publications, number of co-authors and the dependent variable on the number of connections) have been transformed into logarithm (logarithm of the variable + 1). In order to control for unobserved characteristics of the department where the PhD holder obtained the PhD, we included a series of dummy control variables for each department. The first variable of interest was *To industry*, which captured whether the PhD holder had moved to industry. International mobility was captured by a set of variables that distinguished different cases. We distinguished first between local PhD holders who had remained in their countries (base line category in the analyses) and local PhD holders who had moved abroad (*National – abroad*). Second, we identified three categories of foreign PhD holders (who had obtained their PhD in a country different from their country of origin) depending on whether they had stayed in the country where they obtained the PhD (*Foreign – in host country*), returned to their country of origin (*Foreign – in home country*), or moved to a different country (*Foreign – in third country*).

Finally, *Coauthors local* and *Coauthors international* measured academic collaborations in the country where the PhD had been obtained and abroad.

## 5. Results

Table 3 reports the results of our econometrical model. We gradually include our variables of interest from column I (a and b) to column III (a and b). The first three columns report results for the first equation (selection equation), which estimated the probability of the student having a LinkedIn account (column Ia, IIa and IIIa). The last three columns (Ib, IIb and IIIb) report results for the second equation, which studied the expected number of LinkedIn connections conditional on having a LinkedIn account.

---

[4] In addition, the econometrics literature recommends including at least one variable which has a significant coefficient in the selection equation but is not included and has no significant impact in the second equation (Puhani, 2000). Unfortunately, we did not have a variable of this kind.

[5] Note that the average number of publication and citations may be largely different across different scientific fields. In our analysis, we focus on engineering and we include controls for the different departments where the PhD graduates obtained their PhD. Nonetheless, these variables may partly capture unobserved heterogeneity across different sub-fields of research and, therefore, have to be simply considered as control variables and the relevant coefficients have to be interpreted with caution.

We start by commenting on the results relative to the first equation, which related to hypotheses H1a, H2a, and H3a concerning the use of LinkedIn by PhD holders. Inspection of the main control variables shows a lower probability that females have a LinkedIn account, although the corresponding coefficient is significant only in the first model specification. This is consistent with the overall men/women ratio for this SNS: LinkedIn is one of the few SNSs in which men are more present and engaged than women (e.g., Duggan et al., 2015; Duggan and Smith, 2014).

We do not find an effect of age, maybe because age did not vary largely in our sample. Conversely, we find that the amount of time taken to obtain the PhD has a positive effect on the probability of having a LinkedIn account. One possible explanation is that a longer stay in a given affiliation for the PhD is associated with a greater need to recreate external networks. Furthermore, we find in column III that the higher the number of publications during the PhD, the lower the probability of having a LinkedIn account.

These two latter results are notable because students that publish more during the PhD and/or obtain the PhD in a shorter period may have a higher propensity and more opportunities to remain in academia; and this, according to our hypothesis H1a, makes the use of SNSs such as LinkedIn less important. Moreover, publications are a signal of quality (in academia, but potentially also for positions in industry) so that PhD graduates with such a signal may resort less to other systems to signal their quality.

Coherently with our hypothesis H1a, PhD holders moving to the industry sector are more likely to have a LinkedIn account.

We do not find any significant impact of international mobility indicators. Hence, we cannot confirm our hypothesis H2a that PhD holders moving to a country different from the one in which they obtained their PhD are more likely to have a LinkedIn account.

On the contrary, we find that PhD holders with a higher number of co-authors abroad during the PhD have a higher probability of using LinkedIn, coherently with our hypothesis H3a that PhD holders with larger international networks of co-authors are more likely to have a LinkedIn account.

We now comment on the results relative to the second equation. This related to the hypotheses H1b, H2b, and H3b concerning the extent of the LinkedIn networks of those PhD holders with LinkedIn accounts.

We find that age, which has no significant effect on the probability of having a LinkedIn account, is instead negatively correlated with the number of connections. This is in line with the expectation that younger individuals tend to make more active use of LinkedIn. In fact, evidence shows that younger individuals have higher adoption rates of Internet platforms (OECD, 2015) and are more inclined to have wider networks on SNSs (Smith, 2014). We do not find any effect of other control variables.

Again, considering our variables of interest, we find that the choice of moving to industry exhibits a strong positive correlation with the number of LinkedIn connections, coherently with our hypothesis H1b.

Second, we find that PhD students who move abroad after obtaining their PhD have a higher number of connections compared with other students. Furthermore, interestingly, foreign students who have moved back to their country of origin have a lower number of connections. This result is therefore only partially coherent with our hypothesis H2b that PhD holders moving to a country different from the one where they obtained their PhD have a larger network of connections in LinkedIn, and suggests, more generally, that larger networks are positively associated to movements of the PhD graduates to countries other than their own.

Finally, the number of co-authors, either local or abroad, is not reflected in a higher number of connections. Consequently, we cannot maintain our hypothesis H3b that PhD holders with larger

8 S.H. Baruffaldi et al. / Research Policy xxx (2017) xxx–xxx

**Table 3**
Heckman selection model on *LinkedIn account* and *LinkedIn connections*.

| | Selection equation: LinkedIn account | | | Outcome equation: LinkedIn connections | | |
|---|---|---|---|---|---|---|
| | I a | II a | III a | I b | II b | III b |
| Female | −0.303* | −0.148 | −0.164 | −0.135 | −0.010 | 0.000 |
| | (0.182) | (0.213) | (0.218) | (0.161) | (0.169) | (0.164) |
| Age | −0.020 | −0.002 | −0.012 | −0.073* | −0.058* | −0.059* |
| | (0.029) | (0.031) | (0.031) | (0.038) | (0.035) | (0.035) |
| Time for PhD | 0.219*** | 0.219** | 0.239** | 0.084 | 0.090 | 0.096 |
| | (0.082) | (0.096) | (0.102) | (0.063) | (0.061) | (0.063) |
| Publications | −0.117 | −0.178 | −0.555** | 0.095 | 0.056 | 0.086 |
| | (0.096) | (0.115) | (0.222) | (0.066) | (0.063) | (0.138) |
| Citations | 0.001 | 0.004 | 0.002 | 0.001 | 0.002 | 0.002 |
| | (0.003) | (0.005) | (0.006) | (0.002) | (0.002) | (0.002) |
| To industry | | 1.802*** | 1.870*** | | 0.623*** | 0.617*** |
| | | (0.285) | (0.288) | | (0.120) | (0.124) |
| National – abroad | | 0.252 | 0.242 | | 0.296** | 0.290** |
| | | (0.272) | (0.269) | | (0.142) | (0.142) |
| Foreign – in host country | | 0.113 | 0.067 | | 0.024 | 0.019 |
| | | (0.290) | (0.298) | | (0.168) | (0.167) |
| Foreign – in home country | | −0.454 | −0.527 | | −0.404* | −0.420* |
| | | (0.343) | (0.354) | | (0.238) | (0.235) |
| Foreign – in third country | | −0.169 | −0.213 | | 0.150 | 0.121 |
| | | (0.305) | (0.325) | | (0.243) | (0.243) |
| Coauthors local | | | 0.195 | | | −0.056 |
| | | | (0.167) | | | (0.108) |
| Coauthors abroad | | | 0.299** | | | 0.033 |
| | | | (0.138) | | | (0.081) |
| Department dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 0.877 | −0.139 | 0.158 | 7.016*** | 6.133*** | 6.166*** |
| | (1.025) | (1.092) | (1.126) | (1.329) | (1.207) | (1.211) |
| Wald test | | | | 52.61 | 142.4 | 145.2 |
| Observations | 422 | 422 | 422 | 358 | 358 | 358 |

Note: The table reports results for the Heckman selection model. Columns I a, II a and II a report the first equation results for three model specifications where the dependent variable was *LinkedIn account*. Columns I b, II b and II b report the second equation results for the same three model specifications where the dependent variable was *LinkedIn connections*. Robust standard errors are in parentheses. *, **, *** indicate statistical significance at the 10, 5 and 1% levels, respectively.

international networks of international coauthors have larger networks of connections in LinkedIn.

In summary, and focusing on our main variables of interest, we find that the evidence is consistent with the hypotheses that PhD holders moving to the industry sector are more likely to have a LinkedIn account and to have a larger network of connections in LinkedIn, controlling for factors such as gender, age, publications, citations received, research field, and department affiliation. Indeed, both the opening of a LinkedIn account and the number of connections in LinkedIn correlate positively and significantly with PhD holders moving to the industry sector. In addition, PhD holders are more likely to use LinkedIn if they have co-authors abroad. Foreign PhD holders who have returned to their country are more likely to have fewer contacts in LinkedIn, while national PhD holders who have gone abroad are more likely to have more contacts in LinkedIn.

## 6. Conclusions

In this study, we have focused on determinants that lead PhD holders to register and develop wider or narrower networks on LinkedIn. We have found that PhD holders who move to industry, go abroad, and have international collaborations are more likely to use LinkedIn. In particular, the probability of having a LinkedIn account is higher for PhD holders that move to industry and, to a lesser extent, for those who had international collaborations during their graduate studies. International mobility has no correlation with the probability of having an account, but it is positively correlated with the size of the network. These results suggest that LinkedIn, for PhD holders, can be a means to seek career opportunities and collaborations outside the academic environment where they obtained their PhD. In this sense, SNSs may help overcome geographic boundaries and information asymmetries (Autor, 2001; Varian, 2010).

In our study, we have also provided a methodological discussion related to the use of SNSs data for research. Using fine-grained data gathered from LinkedIn and complemented with additional data sources, we have shown that LinkedIn can be used as a new data source to deepen the analysis of the behavior of highly skilled individuals. The fact that some of our most intuitive hypotheses have been verified suggests that LinkedIn may be used as a reliable data source in future studies. However, in the context of each specific analysis, problems of self-selection, self-reporting, and self-promotion should be taken into account. The adoption of complementary sources of data is clearly advisable.

These considerations suggest that LinkedIn can furnish information crucial for solving an important policy problem, i.e., the job-seeking strategies of recent PhD graduates and doctorate holders in general. Given the growing supply of doctorate holders and the lack of opportunities in academic institutions, the majority of PhD holders must find jobs in industry. On studying how the careers of doctorate holders evolve, several studies have found a mismatch between PhD holders' skills and expectations and the needs of industry (Huisman et al., 2002; Mangematin, 2000; McAlpine and Emmioğlu, 2015; Nogueira et al., 2015; van der Weijden et al., 2016; Wendler et al., 2012). The solutions suggested include an active role of academic institutions in providing PhD graduates with information on career prospects outside academia, and practical course-based preparation for research posts in the private sector. In this context, LinkedIn can be a useful tool with which to find and track the careers of those PhD holders who have left academia, see the impact of different solutions adopted for the mismatch prob-

lem, and involve PhD graduates in ad hoc surveys (e.g. following Auriol et al., 2012).

We have highlighted that SNSs may play a significant role in facilitating the mobility of PhD holders towards industry. Future research may study whether the observed behavior of PhD graduates is justified, i.e. whether a greater (or any) presence on SNSs such as LinkedIn actually enhances high skilled individuals' employability and whether they obtain career benefits from having both a LinkedIn account and a high number of connections.

Furthermore, future research may study the relationship between SNSs connections, co-authorship and citations received.

We acknowledge some limitations of our work that can lead to further research. First, we have considered only PhD holders from two European and technical universities. The analyses could be expanded to other disciplines, other countries, and other categories of highly skilled workers. Results may differ in contexts where the use of LinkedIn is higher (or lower), according to different expectations on the usefulness of LinkedIn for seeking a job and expanding professional networks.

Second, it would be useful to consider the alternative (or complementary) use of SNSs different from LinkedIn, as well as additional variables that could be retrieved (e.g. in order to capture the quality of networks, actual online interactions etc.). The use of additional sources of personal information may also attenuate the issue arising from the differential attrition to which our study, despite our efforts, is not immune.

Third, we provide evidence in support of our hypotheses after controlling for several individual characteristics, but other confounding factors for which we cannot control for in our data may play a role. For instance, PhD holders may have studied in other countries for some periods, they may have attended international conferences or they may have performed research in direct collaboration with a company. These factors may affect both the observed carrier choices and the propensity to make use of SNSs. Similarly, PhD graduates may use LinkedIn to maintain contacts with people living abroad for professional reasons other than those considered in this work. The analyses could therefore be expanded to take these alternative explanations into account.

## Acknowledgments

## References

Abramo, G., D'Angelo, C.A., Solazzi, M., 2011. The relationship between scientists' research performance and the degree of internationalization of their research. Scientometrics 86 (3), 629–643.

Acemoglu, D., 1998. Why do new technologies complement skills? Directed technical change and wage inequality. Q. J. Econ. 113 (4), 1055–1089.

Ackers, L., 2005. Moving people and knowledge: scientific mobility in the european union. Int. Migr. 43 (5), 99–131.

Agrawal, A., 2006. Engaging the inventor: exploring licensing strategies for university inventions and the role of latent knowledge. Strateg. Manage. J. 27 (1), 63–79.

Altbach, P.G., Knight, J., 2007. The internationalization of higher education: motivations and realities. J. Stud. Int. Educ. 11 (3–4), 290–305.

Atasoy, H., 2013. The effects of broadband internet expansion on labor market outcomes. Ind. Labor Relat. Rev. 66 (2), 315–345.

Auriol, L., Schaaper, M., Felix, B., 2012. Mapping careers and mobility of doctorate holders: draft guidelines, model questionnaire and indicators – third edition. In: OECD Science, Technology and Industry Working Papers, 7.

Autor, D.H., 2001. Wiring the labor market. J. Econ. Perspect. 15 (1), 25–40.

Azoulay, P., Graff Zivin, J.S., Manso, G., 2011. Incentives and creativity: evidence from the academic life sciences. RAND J. Econ. 42 (3), 527–554.

Baláz, V., Williams, A.M., Kollár, D., 2004. Temporary versus permanent youth brain drain: economic implications. Int. Migr. 42 (4), 3–34.

Bar-Ilan, J., Haustein, S., Peters, I., Priem, J., Shema, H., Terliesner, J., 2012. Beyond citations: scholars' visibility on the social Web. Proceedings of 17th International Conference on Science and Technology Indicators, 52900, 98–109.

Barjak, F., Li, X., Thelwall, M., 2007. Which factors explain the web impact of scientists' personal homepages? J. Am. Inf. Sci. Technol. 58 (2), 200–211.

Barjak, F., 2006a. Research productivity in the internet era. Scientometrics 68 (3), 343–360.

Barjak, F., 2006b. The role of the internet in informal scholarly communication. J. Am. Inf. Sci. Technol. 57 (10), 1350–1367.

Baruffaldi, S.H., Landoni, P., 2012. Return mobility and scientific productivity of researchers working abroad: the role of home country linkages. Res. Policy 41, 1655–1665.

Baruffaldi, S.H., Landoni, P., 2016. Mobility intentions of foreign researchers: the role of non-economic motivations. Ind. Innov. 23 (1), 87–111.

Baruffaldi, S.H., Visentin, F., Conti, A., 2016. The productivity of science & engineering PhD students hired from supervisors' networks. Res. Policy 45 (4), 785–796.

Beaver, D. deB., Rosen, R., 1978. Studies in scientific collaboration. Part I. The professional origins of scientific co-authorship. Scientometrics 1 (1), 65–84.

Bloch, C., Graversen, E.K., Pedersen, H.S., 2015. Researcher mobility and sector career choices among doctorate holders. Res. Eval. 24 (2), 171–180.

Bonsón, E., Bednárová, M., 2013. Corporate linkedIn practices of eurozone companies. Online Inf. Rev. 37 (6), 969–984.

Borjas, G.J., Bratsberg, B., 1996. Who leaves? The outmigration of the foreign-born. Rev. Econ. Stat. 78 (1), 165–176.

Bourdieu, P., 1986. The forms of capital. In: Richardson, J. (Ed.), Handbook of Theory and Research for the Sociology of Education. Greenwood, New York, NY, pp. 241–258.

Brandi, M.C., 2001. The evolution in theories of the brain drain and the migration of skilled personnel. Studi Emigrazione, 38, Retrieved from http://www.irpps.cnr.it/it/system/files/the_evolution_study.pdf.

Bremner, S., Phung, B., 2015. Learning from the experts: an analysis of Résumé writers' self-presentation on LinkedIn. IEEE Trans. Prof. Commun. 58 (4), 367–380.

Brynjolfsson, E., Oh, J.H., 2012. The attention economy: measuring the value of free digital services on the internet. Thirty Third Int. Conf. Inf. Syst. ICIS 4, 3243–3261.

Burke, M., Kraut, R., Marlow, C., 2011. Social capital on Facebook: differentiating uses and users. CHI'11 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 571–580.

Cairncross, F., 2001. The Death of Distance: How the Communications Revolution Is Changing Our Lives. Harvard Business School Press, Boston, MA.

Calderini, M., Franzoni, C., Vezzulli, A., 2009. The unequal benefits of academic patenting for science and engineering research. IEEE Trans. Eng. Manage. 56 (1), 16–30.

Casey, B.H., 2009. The economic contribution of PhDs. J. High. Educ. Policy Manage. 31 (3), 219–227.

Chan, W.W.Y., Dimmock, C., 2008. The internationalization of universities: globalist, internationalist and translocalist models. J. Res. Int. Educ. 7 (2), 184–204.

Collins, T.A., Knotts, H.G., Schiff, J., 2012. Career preparation and the political science major: evidence from departments. PS: Polit. Sci. Polit. 45 (January), 87–92.

Conti, A., Visentin, F., 2015. Science and engineering Ph.D. students' career outcomes, by gender. PLoS One 10 (8), e0133177.

Crespi, G.A., Geuna, A., Nesta, L., 2007. The mobility of university inventors in Europe. J. Technol. Transf. 32, 195–215.

Cruz-Castro, L., Sanz-Menéndez, L., 2005. The employment of PhDs in firms: trajectories, mobility and innovation. Res. Eval. 14 (1), 57–69.

Czernich, N., 2014. Does broadband internet reduce the unemployment rate?: Evidence for Germany. Inf. Econ. Policy 29, 32–45.

DiMaggio, P., Bonikowski, B., 2008. Make money surfing the web? The impact of internet use on the earnings of U.S. workers. Am. Sociol. Rev. 73 (2), 227–250.

Ding, W.W., Levin, S.G., Stephan, P.E., Winkler, A.E., 2010. The impact of information technology on academic scientists' productivity and collaboration patterns. Manage. Sci. 56 (9), 1439–1461.

Duggan, M., Smith, A., 2014. Social Media Update 2013. Pew Research Center, January. Retrieved from http://www.pewinternet.org/2013/12/30/social-media-update-2013/.

Duggan, M., Ellison, N.B., Lampe, C., Lenhart, A., Madden, M., 2015. Social Media Update 2014. Pew Research Center, January. Retrieved from http://www.pewinternet.org/2015/01/09/social-media-update-2014/.

Dustmann, C., Weiss, Y., 2007. Return migration: theory and empirical evidence from the UK. Br. J. Ind. Relations 45 (2), 236–256.

Forman, C., van Zeebroeck, N., 2012. From wires to partners: how the internet has fostered R & D collaborations within firms. Manage. Sci. 58 (8), 1549–1568.

Fowler, F.J.J., 2013. Survey Research Methods, 5th ed. Sage Publications, Thousands Oaks, CA.

Franzoni, C., Scellato, G., Stephan, P., 2014. The mover's advantage: the superior performance of migrant scientists. Econ. Lett. 122 (1), 89–93.

Freeman, R.B., 2010. Globalization of scientific and engineering talent: international mobility of students, workers, and ideas and the world economy. Econ. Innov. New Technol. 19 (5), 393–406.

Fritsch, M., Krabel, S., 2012. Ready to leave the ivory tower?: Academic scientists' appeal to work in the private sector. J. Technol. Transf. 37, 271–296.

Gaillard, J., Gaillard, A.M., 1997. Introduction: the international mobility of brains: exodus or circulation? Sci. Technol. Soc. 2 (2), 195–228.

Gaillard, A.M., Gaillard, J., 1998. The international circulation of scientists and technologists: a win-lose or win-win situation? Sci. Commun. 20 (1), 106–115.

Golub, B., 2002. Motivational factors in departure of young scientists from Croatian science. Scientometrics 53 (3), 429–445.

Granovetter, M., 1990. The myth of social network analysis as a special method in the social sciences. Connections 12 (1–2), 13–16.

Greenwald, B.C., 1986. Adverse selection in the labor market. Rev. Econ. Stud. 53, 325–347.

Greenwood, J., Kopecky, K.A., 2013. Measuring the welfare gain from personal computers. Econ. Inq. 51 (1), 336–347.

Grubel, H.B., Scott, A.D., 1966. The international flow of human capital. Am. Econ. Rev. 56 (1/2), 268–274.

Guillory, J., Hancock, J.T., 2012. The effect of linkedin on deception in resumes. Cyberpsychol. Behav. Soc. Netw. 15 (3), 135–140.

Herrera, L., Nieto, M., 2015. The determinants of firms' PhD recruitment to undertake R&D activities. Eur. Manage. J. 33 (2), 132–142.

Herrera, L., Muñoz-Doyague, M.F., Nieto, M., 2010. Mobility of public researchers, scientific knowledge transfer, and the firm's innovation process. J. Bus. Res. 63 (5), 510–518.

Hoekman, J., Frenken, K., Tijssen, R.J.W., 2010. Research collaboration at a distance: changing spatial patterns of scientific collaboration within Europe. Res. Policy 39 (5), 662–673.

Horta, H., Veloso, F.M., Grediaga, R., 2010. Navel gazing: academic inbreeding and scientific productivity. Manage. Sci. 56 (3), 414–429.

Huisman, J., de Weert, E., Bartelse, J., 2002. Academic careers from a european perspective: the declining desirability of the faculty position. J. High. Educ. 73 (1), 141–160.

Ioannides, Y.M., Loury, L.D., 2004. Job information networks, neighborhood effects, and inequality. J. Econ. Lit. 42 (4), 1056–1093.

Jöns, H., 2009. Brain circulation and transnational knowledge networks: studying long-term effects of academic mobility to Germany, 1954–2000. Glob. Netw. 9 (3), 315–338.

Jeong, S., Choi, J.Y., Kim, J.-Y., 2014. On the drivers of international collaboration: the impact of informal communication, motivation, and research resources. Sci. Public Policy 41 (4), 520–531.

Jonsen, K., Butler, C.L., Mäkelä, K., Piekkari, R., Drogendijk, R., Lauring, J., Lervik, J.E., Pahlberg, C., Vodosek, M., Zander, L., 2013. Processes of international collaboration in management research: a reflexive, autoethnographic approach. J. Manage. Inq. 22 (4), 394–413.

Kasper, K., 2014. Facebook Is the Social Network of Choice for 86% of the Workforce, but High Mobility Job Seekers Prefer LinkedIn, Jobvite Study Shows, Retrieved June 6, 2015, from http://www.jobvite.com/press-releases/2014/facebook-social-network-choice-86-workforce-high-mobility-job-seekers-prefer-linkedin-jobvite-study-shows/.

Kato, M., Ando, A., 2013. The relationship between research performance and international collaboration in chemistry. Scientometrics 97 (3), 535–553.

Katz, J.S., Martin, B.R., 1997. What is research collaboration? Res. Policy 26, 1–18.

Khoo, S.E., Hugo, G., McDonald, P., 2008. Which skilled temporary migrants become permanent residents and why? Int. Migr. Rev. 42 (1), 193–226.

Kitchin, R., 2014. Big Data, new epistemologies and paradigm shifts. Big Data Soc. 1 (1), 2053951714528481.

Klier, J., Klier, M., Rebhan, V., Thiel, L., 2015. Can social media help to alleviate skilled worker shortage? First insights from the german federal employment agency. Proceedings der 12. Internationalen Tagung Wirtschaftsinformatik, 797–810.

Kwiek, M., 2015. The internationalization of research in Europe: a quantitative study of 11 national systems from a micro-Level perspective. J. Stud. Int. Educ. 19 (4), 1–19.

Lauring, J., Selmer, J., 2010. Is university internationalization bad for performance? Examining two different types of diversity. Int. J. Educ. Res. 49 (4–5), 161–171.

Leydesdorff, L., Wagner, C.S., 2008. International collaboration in science and the formation of a core group. J. Informetr. 2 (4), 317–325.

Lin, N., Dumin, M., 1986. Access to occupations through social ties. Soc. Netw. 8 (4), 365–385.

LinkedIn Corporation, 2011. Company Description, Retrieved April 26, 2016, from http://www.nasdaq.com/markets/spos/company/linkedin-corp-606852-68528.

LinkedIn Corporation, 2015. About Us – LinkedIn Newsroom, Retrieved June 6, 2015, from https://press.linkedin.com/about-linkedin.

Mahoney, M.J., 1979. Review paper: psychology of the scientist: an evaluative review. Soc. Stud. Sci. 9 (3), 349–375.

Mahroum, S., 2000a. Highly skilled globetrotters: mapping the international migration of human capital. R&D Manage. 30 (1), 23–32.

Mahroum, S., 2000b. Scientists and global spaces. Technol. Soc. 22 (4), 513–523.

Mangematin, V., 2000. PhD job market: professional trajectories and incentives during the PhD. Res. Policy 29 (6), 741–756.

Martin-Rovet, D., 2003. Opportunities for Outstanding Young Scientists in Europe to Create an Independent Research Team. European Science Foundation, Strasbourg.

Mas-Bleda, A., Aguillo, I.F., 2013. Can a personal website be useful as an information source to assess individual scientists?: The case of European highly cited researchers. Scientometrics 96, 51–67.

Mas-Bleda, A., Thelwall, M., Kousha, K., Aguillo, I.F., 2014. Do highly cited researchers successfully use the social web? Scientometrics 101 (1), 337–356.

McAlpine, L., Emmioğlu, E., 2015. Navigating careers: perceptions of sciences doctoral students, post-PhD researchers and pre-tenure academics. Stud. High. Educ. 40 (10), 1770–1785.

Merton, R.K., 1973. The Sociology of Science: Theoretical and Empirical Investigations. University of Chicago Press, Chicago.

Meyer, J.-B., 2003. Policy implications of the brain drain's changing face. In: Policy Brief, Science and Development Network, Retrieved from http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN022374.pdf.

Montgomery, J.D., 1991. Social networks and labor-market outcomes: toward an economic analysis. Am. Econ. Rev. 81 (5), 1408–1418.

Newland, K., 2009. Circular migration and human development. Hum. Dev. Res. Pap., 42.

Nikolaou, I., 2014. Social networking web sites in job search. Int. J. Sel. Assess. 22 (2), 179–189.

Nogueira, M.M., Heywood-Roos, R., Phillips, S., Scholz, B., Hynes, M., 2015. Career Tracking of Doctorate Holders: Pilot Project Report. European Science Foundation, Strasbourg.

OECD, 2015. Measuring the Digital Economy.

Orduña-Malea, E., Ontalba-Ruipérez, J.-A., 2013. Selective linking from social platforms to university websites: a case study of the Spanish academic system. Scientometrics 95 (2), 593–614.

Ortega, J.L., 2015. Disciplinary differences in the use of academic social networking sites. Online Inf. Rev. 39 (4), 520–536.

Ota, H., Watanabe, A., 2007. The International Mobility of Researchers: Policy Support at National and Institutional Levels, Retrieved from http://hermes-ir.lib.hit-u.ac.jp/rs/handle/10086/14561.

Pezzoni, M., Sterzi, V., Lissoni, F., 2012. Career progress in centralized academic systems: social capital and institutions in France and Italy. Res. Policy 41 (4), 704–719.

Ponzo, M., Scoppa, V., 2010. The use of informal networks in Italy: efficiency or favoritism? J. Socio Econ. 39 (1), 89–99.

Puhani, P., 2000. The Heckman correction for sample selection and its critique. J. Econ. Surv. 14 (1), 53–68.

Qiang, Z., 2003. Internationalization of higher education: towards a conceptual framework. Policy Futures Educ. 1 (2), 248–270.

Roach, M., Sauermann, H., 2010. A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry. Res. Policy 39 (3), 422–434.

Ronda-Pupo, G.A., Díaz-Contreras, C., Ronda-Velázquez, G., Ronda-Pupo, J.C., 2015. The role of academic collaboration in the impact of Latin-American research on management. Scientometrics 102 (2), 1435–1454.

Rostan, M., Ceravolo, F.A., 2015. The internationalisation of the academy: convergence and divergence across disciplines. Eur. Rev. 23 (S1), S38–S54.

Salt, J., 1997. International movements of the highly skilled. In: OECD Social, Employment and Migration Working Papers, 3.

Sauermann, H., Cohen, W.M., 2010. What makes them tick? employee motives and firm innovation. Manage. Sci. 56 (12), 2134–2153.

Scellato, G., Franzoni, C., Stephan, P., 2015. Migrant scientists and international networks. Res. Policy 44 (1), 108–120.

Siow, A., 1991. Are first impressions important in academia? J. Hum. Resour. 26 (2), 236–255.

Smith, A., 2014. Six New Facts About Facebook, Retrieved February 3, 2014, from http://www.pewresearch.org/fact-tank/2014/02/03/6-new-facts-about-facebook/.

Smith, A., 2015. Searching for Work in the Digital Era. Pew Research Center, Washington, DC, Retrieved from http://www.pewinternet.org/2015/11/19/searching-for-work-in-the-digital-era/.

Stephan, P.E., 2012. How Economics Shapes Science. Harvard University Press, Cambridge, MA.

Thorn, K., Holm-Nielsen, L.B., 2008. International mobility of researchers and scientists: policy options for turning a drain into a gain. In: Solimano, A. (Ed.), The International Mobility of Talent: Types, Causes, and Development Impact. Oxford University Press, Oxford, pp. 145–167.

Trippl, M., 2013. Scientific mobility and knowledge transfer at the interregional and intraregional level. Reg. Stud. 47 (10), 1653–1667.

Van Bouwel, L.A.C., 2010. International Mobility Patterns of Researchers and Their Determinants, Retrieved from http://www2.druid.dk/conferences/viewpaper.php?id=501842&cf=43.

Varian, H.R., 2010. Computer mediated transactions. Am. Econ. Rev.: Pap. Proc. 100 (2), 1–10.

Wagner, C.S., Leydesdorff, L., 2005. Network structure, self-organization, and the growth of international collaboration in science. Res. Policy 34 (10), 1608–1618.

Walsh, J.P., Kucker, S., Maloney, N.G., Gabbay, S., 2000. Connecting minds: computer-mediated communication and scientific work. J. Am. Soc. Inf. Sci. 51 (14), 1295–1305.

Ward, J., Bejarano, W., Dudás, A., 2015. Scholarly social media profiles and libraries: a review. LIBER Q. 24 (4), 174.

Wendler, C., Bridgeman, B., Markle, R., Cline, F., Bell, N., McAllister, P., Kent, J., 2012. Pathways Through Graduate School and Into Careers. Educational Testing Service, Princeton, NJ.

Williams, A.E., Woodacre, M.A., 2016. The possibilities and perils of academic social networking sites. Online Inf. Rev. 40 (2), 282–294.

Winkler, A.E., Levin, S.G., Stephan, P.E., 2010. The diffusion of IT in higher education: publishing productivity of academic life scientists. Econ. Innov. New Technol. 19 (5), 481–503.

Zellner, C., 2003. The economic effects of basic research: evidence for embodied knowledge transfer via scientists' migration. Res. Policy 32 (10), 1881–1895.

Zhou, P., Lv, X., 2015. Academic publishing and collaboration between China and Germany in physics. Scientometrics 105 (3), 1875–1887.

Zide, J., Elman, B., Shahani-Denning, C., 2014. LinkedIn and recruitment: how profiles differ across occupations. Empl. Relations 36 (5), 583–604.

van Dijck, J., 2013. You have one identity: performing the self on Facebook and LinkedIn Media. Cult. Soc. 35 (2), 199–215.

van der Weijden, I., Teelken, C., de Boer, M., Drost, M., 2016. Career satisfaction of postdoctoral researchers in relation to their expectations for the future. High. Educ. 72 (1), 25–40.