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Networks in science: women's research collaborations and the old boys' club

Abstract[1]

The recognition of the social nature of academic research has been increasing steadily. Among other approaches, the role of networks in science, especially in research productivity and excellence has gained distinguished attention in the past decades. On the one hand, networks are core elements of the advancement of science, on the other hand, they are means to career mobility for researchers. However, access to formal and informal networks is not equal for researchers; and there is high gender inequality in several segments of networking. The aim of this paper is to provide an overview of formal and informal networks in science, with special attention to gender inequalities. The paper explores the main characteristics of networks in science; gender differences in collaboration, mentoring and supporting networks; and evaluates the phenomenon of the "old boys' club" – the informal networks in male dominated fields of science.

Keywords: network, research, science, informal network, collaboration, women, old boys' club.

Absztrakt

A tudományos kutatások társas természetének felismerése egyre nagyobb figyelmet kap napjaink tudományos munkáiban. Több más megközelítés mellett jelentősen megnövekedett a kapcsolathálóknak (networks) a tudományos kutatásban – azon belül is a tudományos teljesítményben és kiválóságban – betöltött szerepének vizsgálata. A kapcsolathálók egyrészt a tudomány előrehaladásának alapelemei, másrészt a kutatói mobilitás eszközei. Ugyanakkor a kutatónők sok esetben nem tudnak bekapcsolódni a különböző formális és informális hálózatokba, és az egyes hálózatokban is jelentős eltérések mutatkoznak társadalmi nemek alapján. A tanulmány célja rövid áttekintést adni néhány formális és informális kapcsolathálóról a tudományos szférában, különös tekintettel a társadalmi nemek (gender) szerinti különbségekre. A tanulmány először a tudományos kapcsolathálók, azon belül is az együttműködések, a mentorálás és a támogató hálózatok néhány jellegzetességét mutatja be, majd kitér az ún. „öreg fiúk klubja" jelenségre – a férfiak által dominált tudományterületeken jellemzőbb informális hálózatokra.

Kulcsszavak: network, kutatás, tudomány, informális kapcsolatháló, együttműködések, nők, öreg fiúk klubja.

Introduction

The recognition of the social nature of academic research has been increasing steadily. Among other approaches, the role of networks in science, especially in research productivity and excellence has gained particular attention in the past decades. Initial research on the issue of networks in academia focused on only one discipline, sub-discipline or speciality, and claimed that universities hardly can be the sites of cohesive multidisciplinary networks (Friedkin 1978 refers to Blau 1973). Later investigations examining interdisciplinary communications highlighted the existence of multidisciplinary networks within different disciplines (Friedkin 1978). Results show that information sharing can flow through formal and informal networks (Brass 1985), across and within organisations, as well as among individual actors or groups of individual actors (Fernández-Pérez 2015). On the one hand, networks are core elements of the advancement of science: the diffusion of scientific knowledge, the visibility of scientific achievements and the advancement of science are created through the exchange of information and materials in order to combine resources (Haeussler 2011). On the other hand, networks are "strategically chosen means to career mobility" for researchers (Gersick – Bartunek – Dutton 2000). Recent research highlighted new features of networking and claims for its positive

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spillover effects: researchers acquire new knowledge and skills through networking, gaining more influence by embedding them into their research and teaching practice (Rawlings – McFarland 2011; Pataria et al. 2015). Considering its importance, developing and using different networks in science have become central to researchers in terms of their career advancement.

Though being a vital tool for career advancement, the access to these networks is often unequal for individuals. Research examining personal networks used to be gender-blind until Ibarra's publication, in which "theoretical perspective that views women and minorities as active agents who make strategic choices among structurally limited alternatives is offered" (Ibarra 1993:56). A growing body of research has been investigating the gender dimension[2] of social networks since Ibarra's work, including researchers' networks in science (Kegen 2015; Feeney – Bernal 2010). These publications revealed that access to networks is based on different structural and situational factors (Fox 2005), and there is high gender inequality in several segments of networking (Forret – Dougherty 2004; McGuire 2000). As Etzkowitz and colleagues phrased it: "one of the underlying barriers to the success of women scientists is the structure of their social networks" (Etzkowitz – Kemelgor – Uzzi 2000:176).

The aim of this paper is to provide an overview of formal and informal networks in science, with special attention to gender inequalities. Firstly, the paper explores important characteristics of networks in science; the differences between formal and informal networks, collaboration strategies of academia and industry; as well as how networking can limit career opportunities of female researchers. Secondly, the gendered networks of research collaborations, mentoring and supporting in science will be shown in a nutshell. The third section will introduce the phenomena of the so called 'old boys' club" and the "chilly climate" in the fields of science, technology, engineering and mathematics (STEM).

The overview is qualitative. We searched the databases of Scopus, Web of Science, Sciencedirect and Google Scholar based on keywords of 'women network academia', 'informal network', 'old boys' club'. We selected the most appropriate and informative articles according to our goal.

Networks in science

Scientific work has been increasingly based on formal collaborations, such as grant collaborations, mentor-mentee relation, advice and supportive networks, etc. Formal networks coexist with informal networks, and the notion of the latter one is based on the assumption that individuals do not stop being social beings after entering the threshold of their workplace. Organisations are rather web of coalitions, where coalition building is a core element of organisational life (Waldstrøm 2001). Informal networks are often described as a fragile but flexible nervous system, which nets the rigid skeletons, or as the World Wide Web that seems chaotic at the first glance; however it has a structure (Waldstrøm 2001). Informal networks are normative, spontaneous, they fulfil individuals' goals through physical, social and unstructured communication, where the control of mechanism is based on norms, and the leadership is implicit. Meanwhile, formal organisation networks are planned, fulfil the objectives of the organisation, include formally related links between units, and their control mechanism is based on legitimate authority with explicit leadership (Waldstrøm 2001). Formal and informal networks are so intertwined that they can be hardly distinguished. Their level of interaction – to what extent and how they influence each other – is still a question of debate in science (Mintzberg 1983).

Literature describes informal networks through different perspectives, mainly based on the reason of their existence and on contents. The formation and functioning of informal networks are based on unconscious and conscious reasons of individuals. The unconscious reasons are related to psychological functions, according to which informal organisations help individuals to sense of more social reality and they also strengthen their self-esteem and identity. Informal networks function as a kind of defence mechanism; reduce uncertainty and stress that occurs in individuals' life. Meanwhile, conscious reasons are means for individuals by which they gain information and influence within the organisation, often eluding the formal channels of communication (Baker 1981; Han 1983).

2 Apart from the gender dimension, Ibarra (1992, 1995) and others (McGuire 2000; McDonald – Lin – Ao 2009) also focus on other minority groups in science, mainly on ethnic groups. Though results show several similarities to those in relation to gender, including these findings would go beyond the scope of this paper.

Based on several earlier categorisations, Waldstrøm (2001) synthesised four types of links that connect nudes (individuals, dyads, larger subgroups or even whole groups) in networks. The categorisation is content-based and includes unconscious and conscious features of informal networks as well. The *affect* type of network involves trust building and friendship making between the actors, the *political* type means gaining influence and power within the organisation, the *production* type is based on advice networks and on the exchange of knowledge, while the last type, the *cultural network*, implies communication and flow of information (Waldstrøm 2001). Nevertheless, literature generally distinguishes only instrumental (job-related information, expertise, advice) and expressive (exchange of friendship, high level trust) ties between nudes, based on Ibarra's work (1993).

Both formal and informal networks also exist among researchers across different sectors of science, exhibiting different features. There is a two-way flow of information between researchers in academia and industry, which flow differs with regard to the goals, rewards systems and norms of the organisations. Academia is usually guided by the ethos of open science, while industrial researchers are expected to be more "secretive" in how and with whom they share the information (Rosenberg 1990; Partha – David 1994). Researchers in academia rather tend to share their information with their academic colleagues than with their industrial counterparts. By contrast, researchers in industry are less likely to share information with their colleagues working in the same sector. Another feature of information sharing is that while industrial researchers are more inclined to expect the "quid pro quo", academic researchers tend to share information regardless its reciprocity. Meanwhile, new research highlighted that academic researchers are also willing to share information with high competitive value, when they expect reciprocity (Haeussler 2011). Nevertheless, cross-institutional ties have been rapidly increasing recently. The boundaries between academic and industrial science have become blurred, and researchers have become more open for sharing information with their counterparts in the other sectors (Powell et al. 2005). In sum, academic and industrial science are heavily based on information sharing, and there is a higher level of willingness of information sharing when a research organisation follows the norms of open science (Haeussler 2011).

Women's access to both formal and informal networks is often limited, which phenomenon contributes to the unequal situation of women in science – compared to men (Xie – Shauman 2013). The deficit theory (Sonnert – Holton 1996) explains the gender differences in the career outcomes of researchers with the deficits in the scientific environment, where formal and informal structural mechanisms in organisations (for example vertical segregation, networking) can limit the opportunities of female researchers. Gender gaps can occur in several segments of science. There is a gap in the participation: women's proportion is lower on average, especially in knowledge-intensive fields, in the business sector and in decision-making positions (EC 2012). There is a gap in the life courses – since careers are highly influenced by researchers' structural position, situational factors, personal characteristics and marital status – women, compared to men, face more obstacles to their career advancement. Moreover, the intersection of these hindering factors is more frequent in female life courses, for example when academic norms interfere with women's family obligations (Xie – Shauman 2003). Finally, there is the productivity gap in favour of men (Larivière et al. 2013; Abramo – D'Angelo – Murgia 2013), which – with other gender gaps – also marks different career paths for men and women in science: slower career advancement or abandonment of science (Fox 2005; Xie – Shauman 1998). In the following two sections we will focus on how deficits in some segments[3] of formal and informal networking affect women's career outcomes.

Collaborations, mentoring and supportive networks

Though the gender gap in research productivity[4] in science decreases over time, it still prevails during the whole career (Leahey 2006). Reasons for the gap are rooted in personal factors, such as education and capacities; in gender-related structural factors (Moss-Racusin et al. 2012); in organisational factors, such as the rank of the department or

3 Though there are further segments of science where networking plays vital role, such as publication, patenting, promotion, industrial research, we could not introduce them due to the limitations of this paper.

4 For more information on research productivity and on the methods of scientometrics to model of academic careers see the recent study in this volume (Kiss 2018).

its access to strategic information (Gibson – Hardy – Buckley 2014); as well as in situational factors, such as family background (Xie – Shauman 2003). Research productivity positively correlates with research collaborations with other professionals, for example, participating in international grants and publishing in international journals (Abramo – D'Angelo – Di Costa 2009). Research therefore has been increasingly conducted in different types of research collaborations (Jones – Wuchty – Uzzi 2008), and research collaborations significantly depend on researchers' personal networks and embeddedness (Adams, Black, Clemmons and Stephan 2005). However, women have limited or different access to these networks (Larivière et al. 2013), and significant differences can be detected in how male and female researchers build and use their networks (Abramo – D'Angelo – Murgia 2013). Next, we examine differences in two main segments of networking in academia: research, mentor and supportive collaborations.

Examining the literature on research collaborations in science, we found contradictory results with regard to gender inequality. Some studies do not support its existence in collaboration networks (Bozeman – Gaughan 2011; Melkers – Kiopa 2010) and rather emphasise the role of research area, geographical dispersal and academic status in productivity gap (Kegen 2013). Meanwhile, other research found significant differences in collaboration strategies according to gender (Kemelgor – Etzkowitz 2001; Sonnert – Holton 1996), socio-economic background, extraversion or self-esteem (Forret – Dougherty 2004). One main common feature of these results is that women usually have more female collaborators in their networks (Bozeman – Corley 2004), even when their presence in a field is extremely low (Feeney – Bernal 2010). Furthermore, female researchers usually have more restricted collaboration networks (Larivière et al. 2011), and they are less likely to engage in international research collaborations than men (Uhly – Zippel 2015). The way of networking also differs; male researchers generally use more types of fruitful collaboration strategies than their female counterparts: the *instrumental* type of collaboration covers work factors, the *experience* type is based on previous collaboration, and the *mentoring* type includes helping students and young colleagues. Meanwhile, women use only *mentoring* strategies, which is the only factor by which their number of research collaborators can be predicted (Bozeman – Gaughan 2011). Finally, deeper examination revealed that the effect of marital status is significant in the case of both genders: childless men with an academic partner have the highest, while women with full-time employed non-academic partners have the lowest chance of international collaborations (Uhly – Zippel 2015).

Mentoring is also an effective collaboration strategy for researches, for it positively influences personal development, career choice, research productivity, publication and grant success, as well as promotion and incomes (Bozeman – Corley 2004; Sambunjak – Straus – Marusic 2006; Dreher – Ash 1990). As we saw above, women use mentoring as a dominant type of networking, therefore unequal access to this institution can heavily count for research productivity gap. Though there is some research rejecting gender differences in mentoring collaborations as well (Dreher – Ash 1990), more research supports their existence, and differences seem to be more frequent and significant than they are in the case of grant collaborations. A review of 142 articles on the issue of mentoring in medical sciences highlighted that women usually experience more difficulties in finding mentors than their male colleagues, and they are less likely to have mentors (Sambunjak – Straus – Marusic 2006). A survey cited by this review revealed that men are three times as likely as women to evaluate their mentorship positively in terms of their careers outcomes (Osborn – Ernster – Martin 1992). Further results of the review showed that mentors of faculty staff and residents are predominantly men, and women are more likely to have female mentors. Meanwhile, while female residents prefer female mentors, female faculty do not find important the gender factor (Coleman et al. 2005; Palepu et al. 1998).

Earlier research (Etzkowitz et al. 2000) hypothesised that the younger male research generation has been socialising in a more equal domestic environment, therefore their job-related networks would show more gender diversity. This hypothesis was confirmed by a later survey (Feeney – Bernal 2010) showing that male assistant and associate professors have slightly more females in their informal networks for advice about careers and colleagues than professors have. They also receive support from their female colleagues in reviewing their papers, meanwhile, in the case of publication – which has become the strongest index of productivity nowadays –, they are still seeking support from male colleagues. This research examining almost 1500

scientists and engineers – including a total of more than twelve thousands alters (the respondents' network data) – also found that women, as compared to men, have 15 and 18 per cent more women in their advice and support networks, respectively. The field of science also proved to be a predictor, for biologists reported significantly more, female physicists significantly less women in both types of their networks (Feeney – Bernal 2010). This result reflects on the horizontal segregation of women even within STEM fields, where women's presence is higher in biology, and lower in physics.

Networks in the business sector also exhibit gender inequalities (Ibarra 1993; Smith Knopik – Moerer 2014). A more than one thousand-respondent survey carried out in a large financial corporation in the USA (McGuire 2000) provided more evidence that gender differences in the status of network members depend more on structural factors than on personal factors. It also pointed out that the phenomenon of women having members with both lower or higher status in their networks derives from the weaker position of women in the organisation. If women occupy less powerful positions it attracts less powerful members, and, by contrast, if they occupy a powerful position it attracts more powerful members into their networks. In sum, structural positions can constrain how people form their network ties. Meanwhile, training sessions held in this corporation for "high potential" employees excluded women (and people of colour) as potential managers. This finding is especially valuable in the light of the gender composition of the company, where women's presence was higher than that of men (59 per cent). Moreover, professionals in this research were well equipped with networking skills, therefore women's lower status network members and women's lower position in the organisation were due to "structural exclusion from high-ranking and resourceful positions, not a lack of networking knowledge or skills, prevented" (McGuire 2000:519). Based on these results the author concluded that "high-status employees may not have to personally exclude women from their networks because their organizations are already doing it" (McGuire 2000:517).

The old boys' club and the chilly climate

Supportive informal networks play a dominant role in the retention of women in STEM fields (Barnard et al. 2010). They allocate both instrumental resources vital for career outcomes and expressive benefits of friendship, social support, creation and sharing knowledge (Ibarra 1992). Meanwhile, discrimination, social isolation and the exclusion of women from informal networks by men are quite frequent phenomena in male dominated departments, where women are in token positions (Kanter 1977). The isolation refers to exclusion, devaluation and marginalisation of women (Maranto – Griffin 2011), and their cumulated presence in organisations generates the so-called "chilly climate" experienced by women.

The chilly climate alienates women from doing science (Prentice 2000; August – Waltman 2004). A survey of more than two hundred academics above the rank of associate professor in the USA – in the field of social and natural sciences, including engineering – outlined some factors being responsible for the chilly climate for women and its consequences for their careers (Settles et al. 2006). Women in this research reported sexual harassment and the discrimination of women. Those who experienced a sexist climate in their department reported lower level job satisfaction and influence and poorer job outcomes. By contrast, a generally positive, non-sexist climate and effective leadership correlated positively with job outcomes after controlling for harassment and discrimination. The author found significant differences between the fields of science: reports on sexist and chilly climate, hostile environment and sexual harassment were more frequent in the case of natural scientists (Settles et al. 2006).

Exclusions from informal networks are less measurable, for they are less manifested, and are less able to be "caught in the act" than they are in the case of formal networks. There is not a formal joining criterion to these networks, for they are based on the "sameness" and "maleness", working together for years and meeting socially (Durbin 2007). Informal networking is based on unwritten rules and – in male-dominated organisations – on male-imposed unwritten rules (Singh – Kumra – Vinnicombe 2002). Some research suggests that women are often not aware of the existence or importance of informal networks (Burke – Rothstein – Bristor 1995); or have limited access to them due to men trying to maintain their dominance within organisations by the exclusion of women (Ibarra 1992); or because of the gendered division of labour, which enables women with care-giving

responsibilities, and men to pursue a career with leisure habits, such as golf or football – that are all potential informal networks for sharing – often vital – job-relevant information (Durbin 2011).

The literature calls these male-dominated informal networks from where women are excluded in different ways "old boy's networks" (McDonald 2011; Barnard et al. 2010). Women's access to powerful networks could be denied despite their credentials and organisational positions (Kanter 1977; Brass 1985), or they could receive fewer network benefits (Ibarra 1992). In both cases, women are often viewed as individuals having poor social capital lacking the right social contacts (Pini – Brown – Ryan 2004). Women generally perceive these networks as "competitive, aggressive, less than honest, discouraging and discriminatory" (Davis 2001:377-378). Men's talk in these networks often includes discourses discussing women' lives in a "derogatory way", or using sexual banter with "humour" claiming that "they are only joking" (Powell – Bagilhole – Dainty 2006). Though both men and women can feel discomfort because of such talk, it is women who take the majority of it (Faulkner 2006), and these gendered discourses reinforce the "in" and the "out" group characteristics (Watts 2007). In sum, women's exclusion from the exchange and creation of tacit knowledge, from organisational resources and power (Durbin 2011) have negative effects on women's research productivity, promotions and career outcomes (Bencert – Staberg 2000).

Conclusion

Networking is both a core element of the advancement of science and an effective tool for career mobility. Though the retention of women in science, especially in STEM fields is of vital importance, gendered structural mechanisms frequently curb their career opportunities and outcomes (Xie – Shauman 2003). The aim of this paper was to provide an overview on formal and informal networks in science, with special attention to gender inequalities in collaborations, mentoring and supporting networks. Overviewing a wide range of literature we conclude that women still develop different collaborating networks compared to men. They often have limited access to networks (Larivière et al. 2013) and usually have more women network members to whom they are rather linked by expressive network ties (Ibarra 1993; Bozeman – Corley 2004). Inequality is more visible in the case of mentor-mentee relations, where women receive less support and experience lower career outcomes (Sambunjak – Straus – Marusic 2006; Osborn – Ernster – Martin 1992).

Literature on the issue of gendered collaborations and mentoring suggests that the low presence of women in informal networks in STEM fields does not derive from their low presence in the scientific fields. Moreover, the phenomenon of junior female researchers' relying on senior male colleagues in terms of career advice (instrumental ties) cannot be deducted from the fact that senior researchers are more likely to be men. Both arguments are contradicted by results showing that women's networks exhibit more homophile even when women's presence is extremely low in a discipline. However, one can presume slow changes in the case of the younger male generation, which seems to be more open to collaboration with senior female researchers (Feeney – Bernal 2010). Nevertheless, the homophile feature of women's networks may imply that women seek "safe harbours" in ties to other women due to their exclusion from men's networks (Ibarra 1992).

It is a vicious circle that networks could become gendered due to gender inequalities in science, while gendered networks further deepen these inequalities. Fighting against the exclusion from informal networks is far more tilting against windmills than fighting against the exclusion from formal networks. Informal networks are not based on written regulations, therefore proving the exclusion is usually impossible. Furthermore, organisations hardly take responsibility for their employees' informal ties (McGuire 2000). Therefore the phenomena of the chilly climate and the old boys' club are still critical issues in STEM fields. The exclusion of women from vital informal networks alienates women from pursuing a career in science (Maranto – Griffin 2011). Meanwhile, there are mixed findings on whether forming a "counter" network, the "old women's club", or increasing the proportion of women in management would enhance gender equalities or not (Pini et al. 2004). More studies claim (Durbin 2011; Wajcman 1998) that senior women in organisations fail to challenge the gendered structures, because they may not be aware of the existence of such networks, or are not familiar with the nature of them (Rindfleish – Sheridan 2003). In sum, a more positive and supporting environment would enhance women's collabora-

tions, productivity and career outcomes; therefore women should be (more) supported by their departments and colleagues in seeking mentors and more relations with influential members of their disciplines (Settles et al. 2006). It is the limitation of our overview that the results are not suitable for generalisation: gender inequality is more nuanced, and in order to gain an accurate picture, systematic reviews of each segment of networking in science are needed.

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