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in Information Sharing Using
Network Analysis: the Case of
the Austrian Interlocking
Directorship Network in 2009**

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Summary

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Keywords: Glass Ceiling, Gender Diversity, Social Network Analysis

JEL Classification: M14, M5, C60, C4

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Measuring Gender Differences in Information Sharing using Network Analysis: the Case of the Austrian Interlocking Directorship Network in 2009

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Abstract

In recent literature a relevant problem has been the relationship between career/personal contact networks and different career paths. In addition the recent advances in social capital theory have shown the way in which networks impact on personal careers. In particular women's careers appear to be negatively affected by the informational network structure. The main contribution of this work is to propose empirical evidence of this phenomenon by considering the gendered directorship network with relation to Austria and to show the structural differences by gender in the network. By using community detection techniques we have found various communities in which females seem not to be present at all, where females show significantly fewer contacts than males in the network, and finally where the proportion of males exceeds 91%. The results show the predominant role in the network of male directors; these differences are very relevant if we consider the network as a tool of vehicle information and as a power mechanism. In this paper we wish to make an original contribution to the debate of the well-known "glass-ceiling" effect.

Keywords: Glass ceiling, Gender Diversity, Social Network Analysis

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Introduction

Women tend to be under-represented at top levels of management all over the world (Vinnicombe et al, 2008). For this reason it is very important to detect the barriers imposed on women's careers and their access to positions of power. The notion has been defined as the "glass-ceiling effect" and implies that disadvantages tend to be stronger when considering the top of a hierarchy (Cotter Hermsen Ovadia Vannemann 2001). Various explanations have been offered, and Cook and Glass (2013) have reviewed those given in literature: different forms of gender discrimination, an implicit bias against women, gender stereotypes, tokenism and their cultural foundations (Buhmann 2013) and the quality and the type of mentoring. Another significant barrier, the most relevant in the context of this paper, is the lack of social capital in the form of female's position and role in social networks and the subsequent lack of resources and information that come with those networks (Tharenou, 1999). In particular, in this context informational networks (as networks in which the agents exchange information) seem to be important.

One interesting informational network, that has been receiving an increasing amount of attention over the years, is the network of the directors of listed companies. One of the reasons behind the increased attention is the quota legislation approved in some European Countries, among which Norway, France and Italy (Profeta, Amidani Aliberti et al, 2014), which are quickly changing the gender structure of the national networks, providing fresh data for academics.

From a systemic perspective, among the core functions of networks is the transfer and coordination of knowledge *in the form of information*, (Burt 2011). From an individual perspective, managerial performance depends on managers' ability to create, feed and maintain informational networks. A known point is that a manager's career is the outcome of their personal social network. In particular, a large network seems to be beneficial in increasing individual mobility (Podolny and Baron 1997). Research has pointed out that the network structure can be very beneficial for advancement through access to relevant information, to resources and career sponsorship over time (Seibert Kramer Liden 2001, see also Anderson 2008). In particular a "large sparse network of informal ties" (Podolny Baron 1997) appears to be beneficial.

Previous research on networks is based on Granovetter's (1973, 1974) findings. He revealed that job opportunities depend on the nature of an individual's network. Relationships and social capital were found to be a critical factor for the career progression of managers and executives in general (Tharenou, 1997, 1999). Network characteristics have long been a predictor of employment, associated with career development (Burt, 1997) and linked to individuals' social integration and the formation of social ties within networks (Granovetter, 1973, 1983).

From a gendered perspective, Ibarra (1995) and Smith-Lovin, and McPherson (1993) point out the role of the network in supporting women's careers and how the structure of the network (or its topology) is capable of influencing future performance (Ibarra 1997); other researchers investigate how different types of contact in the network are beneficial in "breaking the glass" (placing females in top management positions). In this way the type of network seems to be relevant (Goodman Fields Blum 2003).

Networks are also a source of power, because of the ability of certain players to control the information flow between individuals and what information is shared (Burt, 2001), particularly if centrally positioned (Grønmo and Løyning, 2003). In this sense the evolution of the network analysis techniques of recent years could be extremely useful in understanding whether and how network topology can be considered relevant in order to determine female career paths and access to positions of power.

In this context it is important to consider the relevant network communities as network subgroups (Fortunato 2010, Newman 2004), that is, as the vehicles in which the information and resources can be usefully spread over the network. In this sense it could be very useful to determine the communities within networks and the implications for female careers. Network communities are particularly relevant because the communities are subgroups in the network, in which the actors tend to connect more densely and to be loosely connected with the other communities (Fortunato 2010). At the same time, the network community structure is characterized by modular (densely connected) and hierarchical components (Porter Onnela Mucha 2009). Traditionally, community detection tends to consider only the network structure and not the node attributes (for example the gender of the actors). Usually the characteristics of the nodes are considered in clustering approaches.

The detection of network communities is a very relevant topic in modern literature on network analysis, and various algorithms have been proposed (Fortunato 2010, Newman 2006, Leskovec Lang & Mahoney 2010). An important point after community detection is the statistical characterization of the communities through considering additional variables not taken into account by the network community detection algorithms.

So the aim of this work is to test whether there are differences in sharing information between males and females. For this reason, we specifically consider a test of hypotheses on the Freeman degree by gender (H1). At the same time at a descriptive level it is important to observe in the network the zones of higher inequality of information share. In this sense the female information share index (FSI) is considered, which measures the difference between Freeman's degree by gender and by community. This measure could be very important to characterize the effective sharing of information of the genders, by community.

A second aim of this work is to define whether there are strong barriers to information sharing in Austria related to the proportion of male directors out of the total number of directors. Where there is a higher number of male directors, there are stronger barriers to information sharing. So in this sense, by considering the European thresholds related to the percentage of the male directors of the total, we test the proportion of male directors in the network (H2 more restrictive and H3).

The work is organized as follows: in the first section we describe the theoretical and institutional framework, whereas in the subsequent section we describe the data used and the methodology. Finally, in Section 3 we discuss the results and their implications.

1. The Institutional Context

1.1 The gendered network in a board context

As we have anticipated in the Introduction, networks are essential for the distribution, allocation and control of information among groups, and social capital and network characteristics have been associated with career development and employment.

Timberlake (2005) finds that, despite the rise in the number of females entering the workplace, statistics reveal that they continue to lag behind males in career advancement and in levels of remuneration. Females are hindered in their efforts because of their inability to access social capital that represents a much-needed organizational asset and source of knowledge, resources and networks, crucial for career development.

Social capital and social factors not only explain female advancement to management, but can also contribute to explaining access to corporate boards, that is the particular set of networks that are relevant in this paper. Social capital theory assesses the career-enhancing resources that are available for individuals from the relationships they possess. However, when assessing these resources, it is found that gender impacts the access to and accumulation of social capital (Kumra and Vinnicombe 2010). This is well known in literature, where the number of females on corporate boards is also an indication of their access to power (Sealy, 2013).

With less relational capital available, female candidates are likely to be disadvantaged in their attempt to gain access to board positions because of the male-dominated nature of corporate boards, which tends to exclude gender dissimilar incumbents (Ragins and Sundstrom, 1989). The relational factors that support the accumulation and deployment of social capital thus hamper females; this is also linked to the evidence

that females tend to be in structurally less powerful organizational roles.(Singh, Terjesen, Vinnicombe, 2008).

The importance of access to and connectedness within boards and among boards is also confirmed by several legislative or regulatory governance interventions in Europe, aimed at limiting the number of seats a director can have. Another example is the 2012 Italian legislation on so-called “interlocking” in 2012, i.e. a ban on interlocking directorships for companies operating in the banking, insurance and financial sectors. This regulation was aimed at reducing potential collusion in the financial industry through networks of directors.

1.2 Network Community Detection as a Tool to Measure Lack of Connectedness

Typically, informational networks (such as interlocking directorship networks) share complexity characteristics. So they are not random. In this sense they can be thought of as based on a sum of modules (modularity characteristics). Many networks in different fields seem to be characterized by the modularity structure (Newman 2006). Modularity can also be defined as the capability to discover the best true community structure. Normally the different algorithms that perform community detection (Fortunato 2010, Newman 2006) tend to have different results, and a comparison is necessary. (Leskovec, Lang and Mahoney 2010 and Lancichinetti Fortunato 2009). The different communities could in reality simply be interpreted as actors with similar functions or characteristics (the outcome of each community detection algorithm is the community membership for each node).

Network community detection algorithms have attracted much research attention, and recently many studies have been carried out regarding the problem (Fortunato 2010, Newman 2006). Detecting network communities means discovering those parts of the network which are densely connected internally and weakly connected with nodes related to other communities. Each community can be related to a specific network function. For this reason it is very important to explore the statistical characteristics of each community as in this way it is possible to understand the network structure.

Detecting network communities is relevant because networks, as complex systems, can be considered to be the sum of the parts, which tend to behave differently and to share different characteristics. In practice, the different communities, as different networks, tend to have a different functional role within the network. However, overlapping communities are found. There is no specific definition of the community structure. In reality, networks can be observed as a specific clustering structure. So networks tend to be characterized by an organization of nodes in clusters, and also by the characteristic of many edges specifically joining

many nodes in the same cluster and few edges in different clusters (Fortunato 2010, Newman 2006). In this sense the modularity structure of a network is defined.

An effective method for detecting community structures makes use of the optimization of the network modularity. The statistical problem is related to finding the best partitions in the network. Then we can consider that this problem has very relevant applications in reality. In particular it is possible to apply the community detection methods to solve the problem in the analysis of interlocking financial directorship networks. Here, an understanding of network communities seems to be highly relevant in order to understand the functioning of corporate governance mechanisms. For example, Heemskerk, Daolio and Tomassini (2013) apply the community detection heuristics to the interlocking directorship network in Europe, finding evidence of homogenization in the corporate governance mechanisms within Europe.

At the same time, as we have seen, many authors have pointed out that disadvantages in social capital formation and accumulation and marginalization in networks can adversely affect female access to and progression in careers and organizations. Here, we propose an index to measure the differences in information sharing within the network. In this sense, it is very important to detect the different network zones and consider the attributes of the nodes by computing the differences in information sharing.

At the same time it is important to measure the lack of connectedness that can occur in a network by using quantitative techniques.

1.3 Approaches in Network Community Detection

Various algorithms have been proposed to detect the communities in a network. The first of these was described by Newman (2004). An important issue in the literature is that it is necessary to use a specific algorithm in order to take into account the statistical characteristics of the network. In fact, there is no single algorithm that is superior to another in all cases. Usually, each different algorithm can have different characteristics (and biases), and is able to detect different structures in networks (Leskovec Lang Mahoney 2010). For this reason, different approaches have been proposed in literature (for a discussion see Fortunato 2009 and Newman 2004). In the first group of approaches specific algorithms making different partitions of the network are considered. The second group includes all the different approaches belonging to the clustering and statistical procedures. Last of all, an alternative approach to clustering procedures has been proposed, related to consensus clustering, which typically combines the information related to a

different iteration of a clustering method (Lancichinetti and Fortunato 2012). In this sense, the final results of these algorithms are to obtain a membership vector, so for each node of the network the community of the node is determined. At this point the research problem could be to characterize the network communities statistically using attribute data.

It is necessary to detect the barriers directly by considering the different network structures, and these barriers can be considered by studying the network structures. In particular the network topology can be very relevant in order to explain the spread of information and resources over the network, and could be useful in order to explain career advances. In this way the social network analysis has been considered a relevant tool for analyzing the network structure and the role of females in directorship networks. The structure of the network can be very useful in predicting future career paths. Denser network zones, also defined as “network communities”, allow a closer relationship between the actors (and so enable higher interconnection). It is important to note that complex networks can be considered as the sum of different sub-networks (and a different velocity spread of the information), and so could be relevant in considering the different role of gender diversity in each community. An additional question is related to the issue of whether gender determines the structure of the communities or not. Communities can be characterized differently by considering the majority of female or male directors. The statistical characterization is very useful in order to understand better the internal network mechanisms.

1.4 Different Methods for the Statistical Characterization of the Network Community.

The importance of characterizing the subgroups or the network communities cannot be overstated. In fact, the different hierarchies and structures it is possible to detect within a network community can be very important in defining females' future career paths.

A significant problem is to obtain a first characterization of the different network communities by considering a suitable algorithm. In this way we are able to discover the network characteristics. A review of the approaches to network community detection with node attributes can be found in Yang, McAuley and Leskovec (2014). In particular, the authors classify different approaches in statistical characterization. The authors propose a community detection method from the “edge structure and the node attributes”. So both the data structure represented by the structural characteristics of the networks and the node attributes are considered.

A different approach was recently proposed with the aim of combining the structural information with the node attributes in order to obtain more robust communities (see Viennet 2012 and Steinhäuser Chawla 2008). In this sense, the information about the nodes (the attributes) is an active part of the structural characteristics of the network in determining the network communities.

An approach using statistical analysis to characterize the communities was proposed by Traud et al. (2011) and Traud et al. (2012). In particular, the authors compare the findings at community level with some relevant statistical characterizations. This approach has a two-stage approach: first the determination of the network communities and then the characterization of the communities. So there is no use of attribute data in network community detection. An important way to measure the different characteristics of the communities could be to construct adequate statistical indices.

1.5 Statistical Analysis by Categorical Variables

The previous description is particularly useful in order to analyze the network structure and to observe whether females are central in some zones of the network.

However, we wish to discover whether there is social exclusion in the network. We need to posit three specific hypotheses: the first one concerns the significance of differences in information sharing levels between male and female directors, hence:

H1 Females and males have different sharing information characteristics.

A second hypothesis to test is the significance of barriers to females within the network. So we consider the proportion of males and females in the network. In particular, we compare the percentages of 85% and 91%, which are the percentage of male non-executive board members and executive members. The levels are those chosen by European Commission 2012 and are a credible benchmark.

H2 The proportion of males/females on the boards is less than the 85% level

H3 The proportion of males/females on the boards is less than the 91% level

These points are very important in order to characterize the network characteristics and the diffusion of the information within the same network.

2 Data and Methods

2.1 Data

The research hypotheses were tested on a dataset of the directors sitting on listed Austrian companies in 2009. The directorships and not the directors were considered, the difference being related to directors holding multiple seats. To begin with, we collected observations by considering three information items: the name of the director, the related company and the gender. This dataset offers the opportunity to investigate a relatively close clique, where external factors such as internationalization of the network are minimized. Following appropriate procedures known to Social Network Analysis (Wassermann Faust 2004), the initial data are transformed into a two-way matrix in which each director is placed on a different company board. So each director (in the row) has different directorships in different companies (in the columns).

At this point, the second step is to transform the two-way matrix to the adjacency matrix both for the row (the directors) and the columns (the companies).

For each pair of companies or directors we can have the information about the number of companies and the number of directors in common. By considering the adjacency matrices we are able to analyze the community structure of the network.

Finally, we consider a vector of gender characteristics as attribute data. The gender characteristics are very important in order to characterize the network community structure.

2.2 The Community Detection Strategy

In order to detect the different communities, we start from the adjacency matrix related to the directors. Then we consider the Girvan-Newman method (Girvan Newman 2002 and Newman Girvan 2003) in order to detect the different partitions, or the communities of the network, considered. We obtain different partitions. Each partition is characterized by a different Q Index. In this case the Q Index represents the goodness of fit which shows how good the partition is. The higher the Q value, the better the partition obtained (Prell 2011). Usually the partitions which maximize the Q value are chosen. The problem is that it is usually possible to have more than one particularly good network partitioning (maximum Q value). Here it is necessary to repeat the fragmentation analysis in order to ensure the stability of the results. So we obtain the different partitions and we can consider where each node belongs to the partitions of the network. At this point we can then analyze the two sub-groups identified by the qualitative variables (for example, gender). To effectively analyze the structure of the communities by considering the qualitative

variables, we propose the use of the data structure visualization techniques: in particular the mosaic plot, which is very useful in detecting the relevant characteristics of communities (Friendly 1994 and 1999). These visualization techniques are used in order to explore the data.

2.3 The Statistical Characterization of the Communities

Here we separately consider the problem of community detection and the problem of cluster nodes by their attributes. In particular, we wish to explore whether there are relationships between the node attributes and the network position (the community). Finally, we want to characterize the network by considering the communities and the different node characteristics.

We can start from the best partition obtained, and analyze the results by the qualitative variable considered (for example, gender). The different indices computed for each community are: degree, eigenvector, Bonacich Power, K-step reach, Average Reciprocal Distance and betweenness. The mean is computed by gender for each community. One important computed characteristic for each community is the fraction of males or females in the total.

It is also possible to consider some contingency tables. These are visualized by using the mosaic plots and the compared results. Two values in the tables are relevant: the percentage related to different communities shows the significance of the single characteristic related to all of the communities, whereas the percentage related to the single community is the significance of the characteristic considering the single community.

Finally, we are able to build the FSI index (for each community found), which is simply the difference between the average Freeman's degree computed by females minus the average Freeman's degree computed by males. Analogously it is possible to compute the MSI index for males. The FSI index allows us to observe the different zones in the network in which there are stronger differences in information sharing.

2.4 The Statistical Tests

The exploratory data analysis in this work is useful in order to better describe the network structure and the professional linkages it is possible to detect in the network (by considering the different communities it

is possible to detect in the network). At this point we can consider the statistical hypothesis by using the appropriate statistical test (see Hannemann Riddle 2005). We tested the hypothesis considering a t-test.

We consider for the H1a hypothesis test the means of two groups. Here we take in to account the Freeman's degree for each node as an attribute as a way of measuring the level of information sharing. To perform the test we need to apply a permutation based sampling distribution of the difference between the means related to males and females in the network. In this case we take in to consideration 10,000 trials. Here the null hypothesis shows no differences between the two means of the groups, while the alternative shows significant differences between the means of males and females.

For the H2 and the H3 hypotheses we consider specifically a single sample proportion test. In particular we consider two threshold levels (from the strictest 91% to the less strict 85%), in order to test the significance of the barriers in information sharing for female directors.

The results of the test relating to the H2 and the H3 can be compared with the proportion of male directors in the total by considering the different communities detected in the descriptive part.

3. Results: Gender and Interlocking Directorships in Austria

We start from the adjacency matrices of the companies in order to characterize the network of the companies. The visualization of the network relating to the companies is in fig.1. The company network is visualized by considering a threshold of betweenness of more than 30 (after deleting isolates and pendants), in this way we are able to identify the most central nodes of the network.

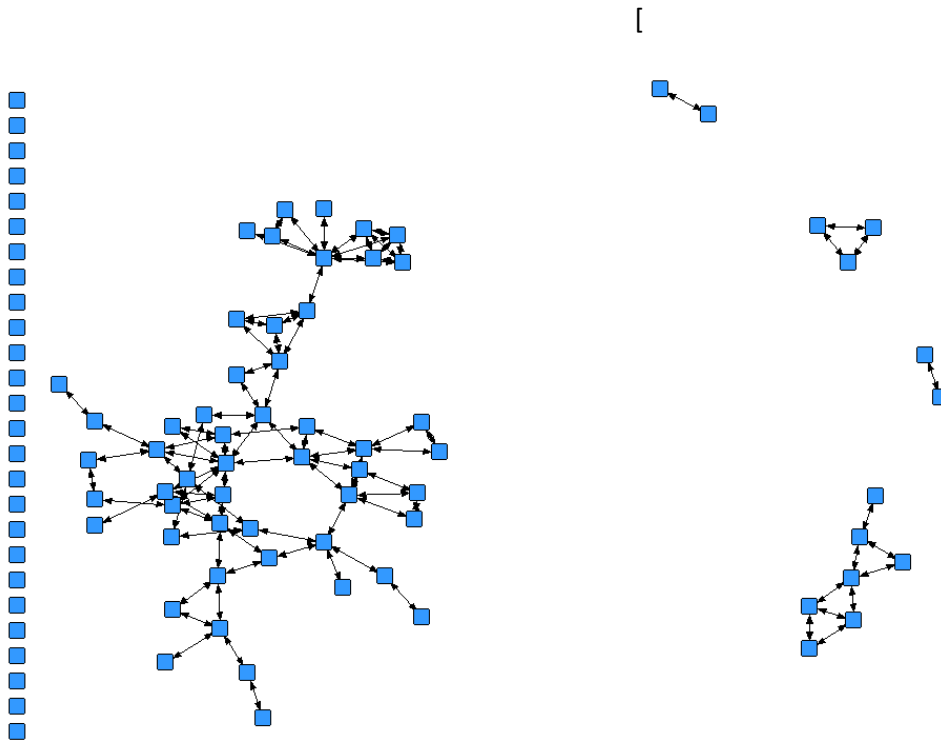


Fig.1 company network in Austria

Starting data are related to the adjacency matrices of the interlocking directors in Austria. We now study the characteristics of the network, in particular the centrality of the network by considering the most central actors in the network represented in tables 1 and 2. At this point we visualize the most central directors (the first ten) both considering the betweenness and Freeman's degree. It is important to note that these two different indices tend to return different information. When considering the first ten directors, no female directors are found. This result is consistent with previous results in other European countries (Santella Drago Polo and Gagliardi 2009).

[table 1 and 2 here]

By considering gender we can obtain the two distinct visualizations for the different networks found by gender in fig. 2 (female), fig.3 (male) and fig.4 (male and female with betweenness more than 5000). Here we observe the differences between the two networks. In particular, fig.2 and fig.3 clearly show the differences of the two networks with regard to males and females. The female director network seems not to be so defined.

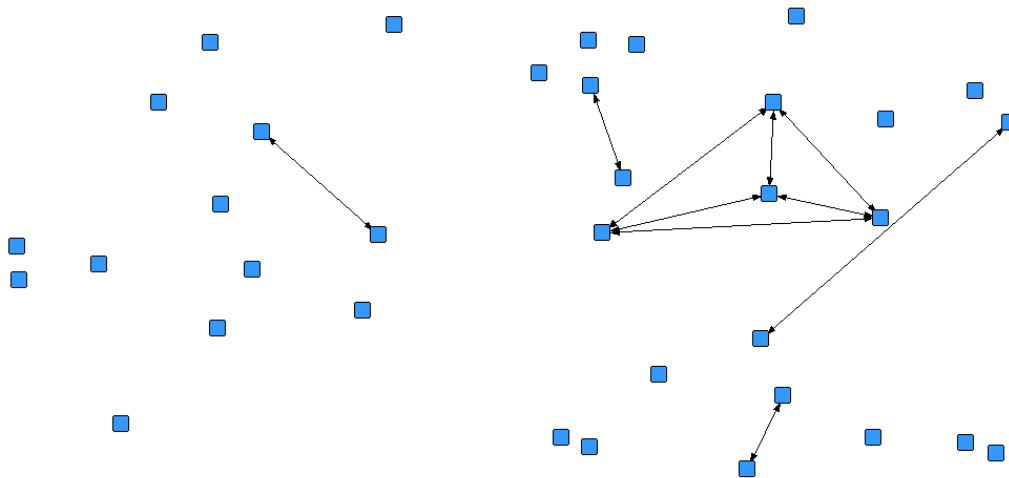


Fig.2 Women director network in Austria

We can see clearly that the female director networks in Austria are very fragmented, and that there is no strong connection between female Austrian directors.

Females tend not to create a specific network. It is also possible to observe that the role of female directors in Austria is not as central in director networks (see tables 1, 2). Also, by considering the entire network and observing the most central part of the network (cut the network at betweenness more than 5000). we can observe that there are no females in this part of the network (fig.5). The results seem to be consistent with other results in the literature (Mac Canna, Brennan & O'Higgins 1998) related to Austria. It is also interesting to compare the results for females in management (Burke Davidson 2000), which confirm the situation in Austria. The results appear similar to another European interlocking directorate network, that of Italy in 2009(see Drago et al. 2011 Santella Drago Polo 2009 and Santella Drago Polo Gagliardi 2009). In

particular, the results seem to confirm the not very relevant role of female directors in interlocking directorship networks.

At this point we can consider the community structure, using the Girvan-Newman algorithm in order to extract the communities from the network. The different communities extracted at the end of the procedure are thirty-five. Each community is related to the different groups of directors, and each community is characterized by considering different director characteristics such as gender, centrality etc.

Then we go on to consider the statistical characterization of the network communities based on the mosaic plots and the different related tables. Table 3 shows the proportion of male directors for each community and the levels of different centrality characteristics of the nodes by females and males. The results here show that females tend to be less central than males (for example, it is possible to consider communities 1 and 2). In the vast majority of the communities in the network, females are not present at all. In particular it is possible to detect some communities by observing the quote of males at 100%. Table 3 also shows some community features computed as mean by gender: degree, eigenvector, Bonacich Power, K-step reach, Average Reciprocal Distance and betweenness. We can compare the single centrality features in each community by nodes and gender.

		Male							Female					
male	female	Community	Between	Eigenvect	ARD	2Step	BonPwr	Degree	Between	Eigenvect	ARD	2Step	BonPwr	Degree
0.83	0.17	1	32	0	18	19	13	8	0	0	16	13	11	7
0.97	0.03	2	1010	0	128	53	473	15	108	0	127	51	518	14
1.00	0.00	3	0	0	5	5	8	6						
1.00	0.00	4	0	0	5	5	8	6						
1.00	0.00	5	0	0	14	14	42	15						
1.00	0.00	6	0	0	5	5	8	6						
1.00	0.00	7	0	0	7	7	12	8						
1.00	0.00	8	0	0	9	9	17	10						
0.80	0.20	9	0	0	4	4	6	5	0	0	4	4	6	5
0.92	0.08	10	3	0	9	12	12	8	0	0	9	12	9	6
1.00	0.00	11	0	0	4	4	6	5						
0.88	0.13	12	0	0	7	7	12	8	0	0	7	7	12	8
0.75	0.25	13	0	0	7	7	12	8	0	0	7	7	12	8
1.00	0.00	14	0	0	0	0	1	1						
1.00	0.00	15	0	0	8	8	15	9						
1.00	0.00	16	0	0	7	7	12	8						
1.00	0.00	17	0	0	3	3	5	4						
1.00	0.00	18	0	0	5	5	8	6						
0.67	0.33	19	0	0	5	5	8	6	0	0	5	5	8	6
1.00	0.00	20	0	0	10	10	21	11						
1.00	0.00	21	0	0	7	7	12	8						
1.00	0.00	22	0	0	7	7	12	8						
1.00	0.00	23	0	0	5	5	8	6						
0.86	0.14	24	0	0	6	6	10	7	0	0	6	6	10	7
1.00	0.00	25	0	0	10	10	21	11						
0.80	0.20	26	0	0	4	4	6	5	0	0	4	4	6	5
0.75	0.25	27	0	0	7	7	12	8	0	0	7	7	12	8
1.00	0.00	28	0	0	4	4	6	5						
1.00	0.00	29	0	0	3	3	5	4						
1.00	0.00	30	3	0	12	15	19	10						
1.00	0.00	31	0	0	7	7	12	8						
1.00	0.00	32	0	0	6	6	10	7						
1.00	0.00	33	0	0	5	5	8	6						
1.00	0.00	34	0	0	3	3	5	4						
0.75	0.25	35	0	0	3	3	5	4	0	0	3	3	5	4

Table 3. Community Characteristics

Results from the FSI (in table 4) Index show interesting findings. Where females are also present in the communities the difference is not strong. Difference is relevant where females are not present at all in the communities, and so the inequality in the sharing of information appears significant.

Community	Female Sharing Information Index (FSI Index)
1	-1
2	-1
3	-6
4	-6
5	-15
6	-6
7	-8
8	-10
9	0
10	-2
11	-5
12	0
13	0
14	-1
15	-9
16	-8
17	-4
18	-6
19	0
20	-11
21	-8
22	-8
23	-6
24	0
25	-11
26	0
27	0
28	-5
29	-4
30	-10
31	-8
32	-7
33	-6
34	-4
35	0

Table 4. FSI index

Finally, by considering the statistical test we are able to reject the null hypothesis of equality of the means of Freeman's degree between males and females at a level of 0.05 (table 5), so we find some differences in the sharing of information between males and females. In particular, the results show empirical evidence that males tend to share more information between male networks, but that females tend to participate less in informational networks. In particular, table 1 considers H1. The results for the H2 and H3 test consider that the level of proportion of male directors is higher than both 85% and 91%. In both cases, by starting from the 85% level we can reject the null hypothesis of proportion equal to 85% at 0.05 significance level, and we can reject the 91% level at the same time.

```

# of permutations:          10000
Random seed:                30990

```

Basic statistics on each group.

		1	2
		Group 1	Group 2
1	Mean	12.627	10.457
2	Std Dev	6.955	5.598
3	Sum	9432.000	366.000
4	Variance	48.379	31.334
5	SSQ	155232.000	4924.000
6	MCSSQ	36138.797	1096.686
7	Euc Norm	393.995	70.171
8	Minimum	1.000	4.000
9	Maximum	58.000	28.000
10	N of Obs	747.000	35.000
11	N Missing	35.000	747.000

SIGNIFICANCE TESTS

Difference in Means	...One-Tailed Tests...		Two-Tailed Test
	Group 1 > 2	Group 2 > 1	
2.169	0.025	0.977	0.0653

Table 5. Statistical Tests: Equality of the Means of the Freeman's Degree

Therefore, we can conclude that there are significant barriers in informational networks for females. The results can be compared with table 3, where we consider the different communities in the network in which female directors are not present at all (H2 and H3 are considered in table 6).

1-sample proportions test with continuity correction (H2)

data: 747 out of 782, null probability 0.85

X-squared = 67.1104, df = 1, p-value < 2.2e-16

alternative hypothesis: true p is greater than 0.85

95 percent confidence interval:

0.9407126 1.0000000

sample estimates:

p

0.955243

1-sample proportions test with continuity correction (H3)

data: 747 out of 782, null probability 0.91

X-squared = 18.996, df = 1, p-value = 6.55e-06

alternative hypothesis: true p is greater than 0.91

95 percent confidence interval:

0.9407126 1.0000000

sample estimates:

p

0.955243

Table 6. Statistical Tests: 1 Sample Proportion with Continuity Test

Future work

It would be very interesting to further investigate the communities according to the concepts of Granovetter's strong and weak ties and Burt's development of Granovetter's theories on the importance of weak ties with his model of structural holes and brokerage.

Further possible avenues for investigation are the structure and change over time of international gendered networks and the effects of quota legislation on the structure and relationship of communities. Other research should focus on the debate on the position of females in the network and in its communities, and the trend over time; in particular whether females are marginalized or not, and the degree of network stability.

Conclusions

In this work we have considered and then analyzed the structure of informational networks. As barriers in information sharing may have adverse effects on career paths, remuneration and access to board positions, it is very important to detect the structural characteristics of these networks. In particular, in this work we have considered the statistical characterization of the network communities of informational networks for Austria. We have detected thirty-five different communities of directors, and in many of these communities females are not present at all. At the same time, similarly to other European countries, females do not have a "girls' only" network, and the female director networks we were able to detect appeared very fragmented. In order to measure the differences in information sharing, we propose an index-defined FSI index, which represents the relevant differences in information sharing within the communities. This result needs to be compared with other characteristics, in particular that females tend to have a significantly lower Freeman's degree than males. At the same time, the proportion of males is higher than the proportion of females and the representation of male directors is significantly higher than the European average. Thus, these results confirm the existence of significant barriers to female advancement and opportunities in Austria.

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