

## **Supplemental Materials**

### **A Network Approach to PhD Students' Well-Being:**

#### **Insights into Risk and Protective Factors**

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## 1. Overview of Items

### **Publication Pressure** (Haven et al., 2019)

1. I experience stress at the thought of my colleagues' assessment of my publication output.
2. I feel forced to spend time on my publications outside working hours.
3. I cannot find sufficient time to work on my publications.
4. I have no peace of mind when working on my publications.
5. I can combine working on my publications with my other tasks.
6. Outside working hours, I do not feel stressed about my publications.

### **Work-Home Conflict** (Geurts et al., 2005)

How often does it happen that ...

1. ...you find it difficult to fulfill your personal obligations because you are constantly thinking about your doctoral studies?
2. ...you do not have the energy to engage in leisure activities with your spouse/family/friends because of your doctoral studies?
3. ...you have difficulty concentrating on your doctoral studies because you are preoccupied with personal matters?
4. ...you do not feel like working because of problems with your spouse/family/friends?

### **Autonomy** (Van Veldhoven et al., 2015)

1. Do you have freedom in carrying out your work activities?
2. Can you decide how your work is executed on your own?
3. Can you personally decide how much time you need for a specific activity?
4. Can you organize your work yourself?

### **Role Clarity** (Pejtersen et al., 2010)

Within my PhD project...

1. ...there are clear objectives.
2. ...I know exactly which tasks I am responsible for.
3. ...I know exactly what is expected of me.

### **Supervisor Support** (Cornér et al., 2017)

1. I receive encouragement and personal attention from my supervisor.
2. I feel that my supervisor is interested in my opinions.
3. I feel appreciated by my supervisor.

4. I can openly discuss any problems related to my doctoral education with my supervisor.
5. I often receive constructive criticism of my skills and expertise.

#### **Development Opportunities** (Van Veldhoven et al., 2015)

1. I learn new things in my doctoral studies.
2. My doctoral studies offer me opportunities for personal growth and development.
3. My doctoral studies give me the feeling that I can achieve something.

#### **Career Control** (Ito & Brotheridge, 2001)

1. I feel I am in control of my career.
2. I have sufficient information that I can plan my career with confidence.
3. I am confident that I know what I will be doing five years from now.

#### **Psychological Capital** (Luthans et al., 2007; Rigotti et al., 2008)

1. At the present time, I am energetically pursuing my work goals. (hope)
2. Right now I see myself as being pretty successful at work. (hope)
3. At this time, I am meeting the work goals that I have set for myself. (hope)
4. When things are uncertain for me at work, I usually expect the best. (optimism)
5. I always look on the bright side of things regarding my work. (optimism)
6. I'm optimistic about what will happen to me in the future as it pertains to work. (optimism)
7. When difficulties arise at work, I know how to solve them. (efficacy)
8. Although it takes me a lot of time and energy, I achieve what I want at work. (efficacy)
9. If something new comes up at work, I always know how to deal with it. (efficacy)
10. When I have a setback at work, I have trouble recovering from it, moving on. (resilience)
11. I usually manage difficulties one way or another at work. (resilience)
12. I can get through difficult times at work because I've experienced difficulty before. (resilience)

#### **Burnout** (Pyhältö et al., 2009)

1. My workload is often too high.
2. My doctoral studies are too stressful for me.
3. I worry about my thesis in my free time.
4. I am stressed out by the workload, deadlines and competition in my doctoral studies.
5. I have to force myself to work on my thesis.
6. It is difficult for me to find meaning and purpose in my doctoral studies.
7. I am not motivated by the content of my doctoral studies.

**Work Engagement (Löfström & Pyhältö, 2020)**

1. When I conduct my doctoral research, I feel that I am bursting with energy.
2. I find the doctoral research that I do full of meaning.
3. Time flies when I'm doing my doctoral research.
4. When doing my doctoral research, I feel vigorous.
5. I am enthusiastic about my doctoral research.
6. When I am doing my doctoral research, I forget everything else around me.
7. My doctoral research inspires me.
8. I feel happy when I start working on my doctoral research.
9. I am immersed in my doctoral research.

## 2. Results of the Stability Analysis

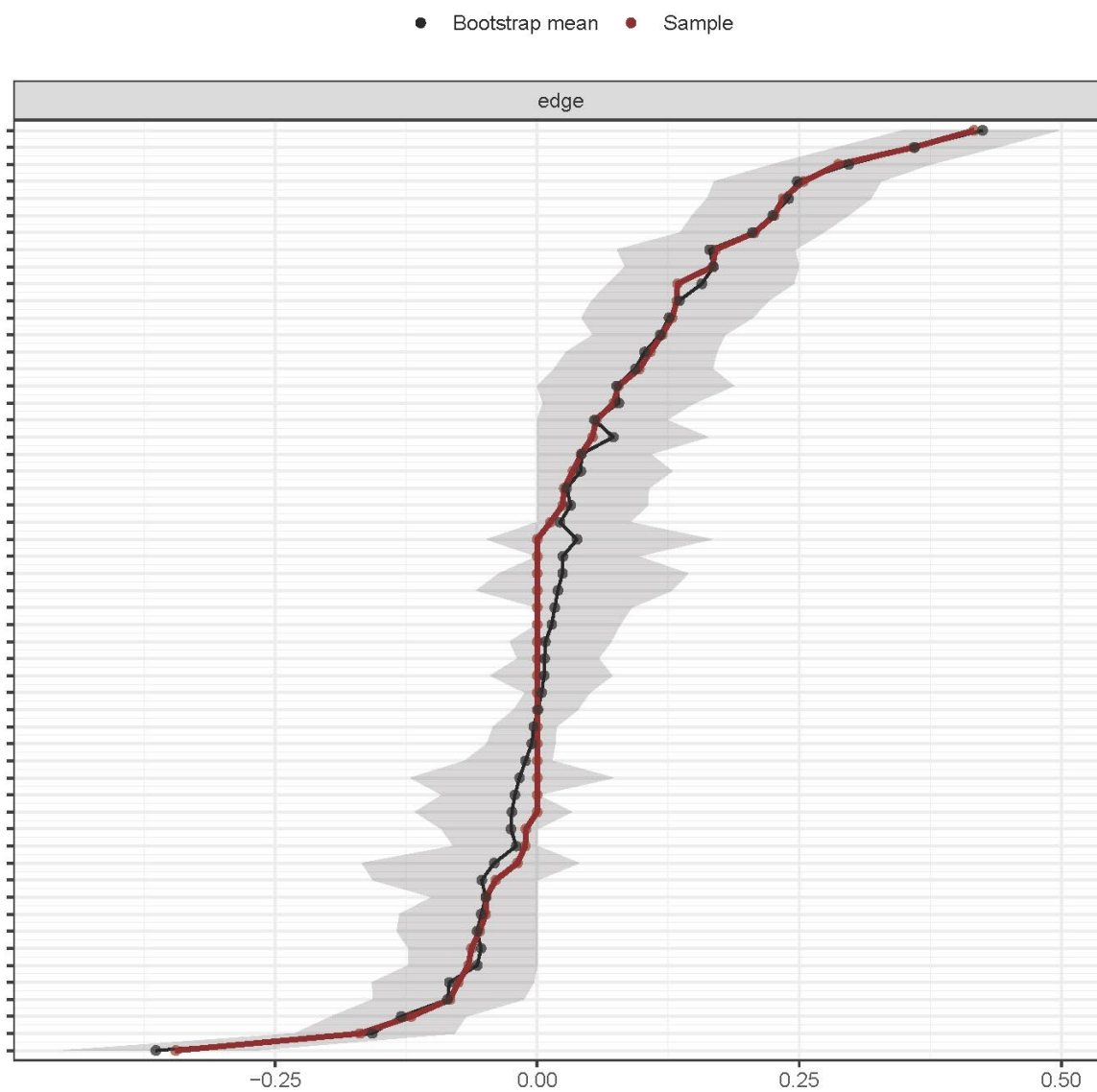
We used bootstrap routines to examine a) the accuracy of the edge weights, that is whether connections within the network are prone to sampling error and b) the stability of centrality indices, that is whether centrality indices remain similar with less observations (Epskamp et al., 2018).

The accuracy of estimates was assessed using the *bootnet* function in *R*. Specifically, to assess edge weight accuracy, we constructed 95% confidence intervals for each edge using a nonparametric bootstrap approach with 1000 bootstrap samples. The confidence intervals were relatively narrow for most edges (wide confidence intervals imply caution regarding interpretation of edge strength; Burger et al., 2022), indicating that the strength of edges can be interpreted with confidence (for a visual representation, see Figure S1).

We assessed whether node strength centrality was stable, by using a case-dropping subset bootstrap based on 1000 bootstrapped samples which assesses if centrality estimates are retained in a subset of the data. The analysis indicated that node strength was retained in a smaller subset of the sample (for a visual representation, see Figure S2). Additionally, the correlation stability coefficient (*CS*-coefficient) which quantifies the stability of centrality indices using subset bootstraps was .75, indicating that 75% of cases could be dropped to retain, with 95% certainty, a correlation of .70 (or higher) between the original centrality indices and the centrality indices that were estimated based on the subset. A *CS*-coefficient should not be smaller than .25 and preferably above .50 to indicate a stable result (Epskamp et al., 2018).

**Figure S1**

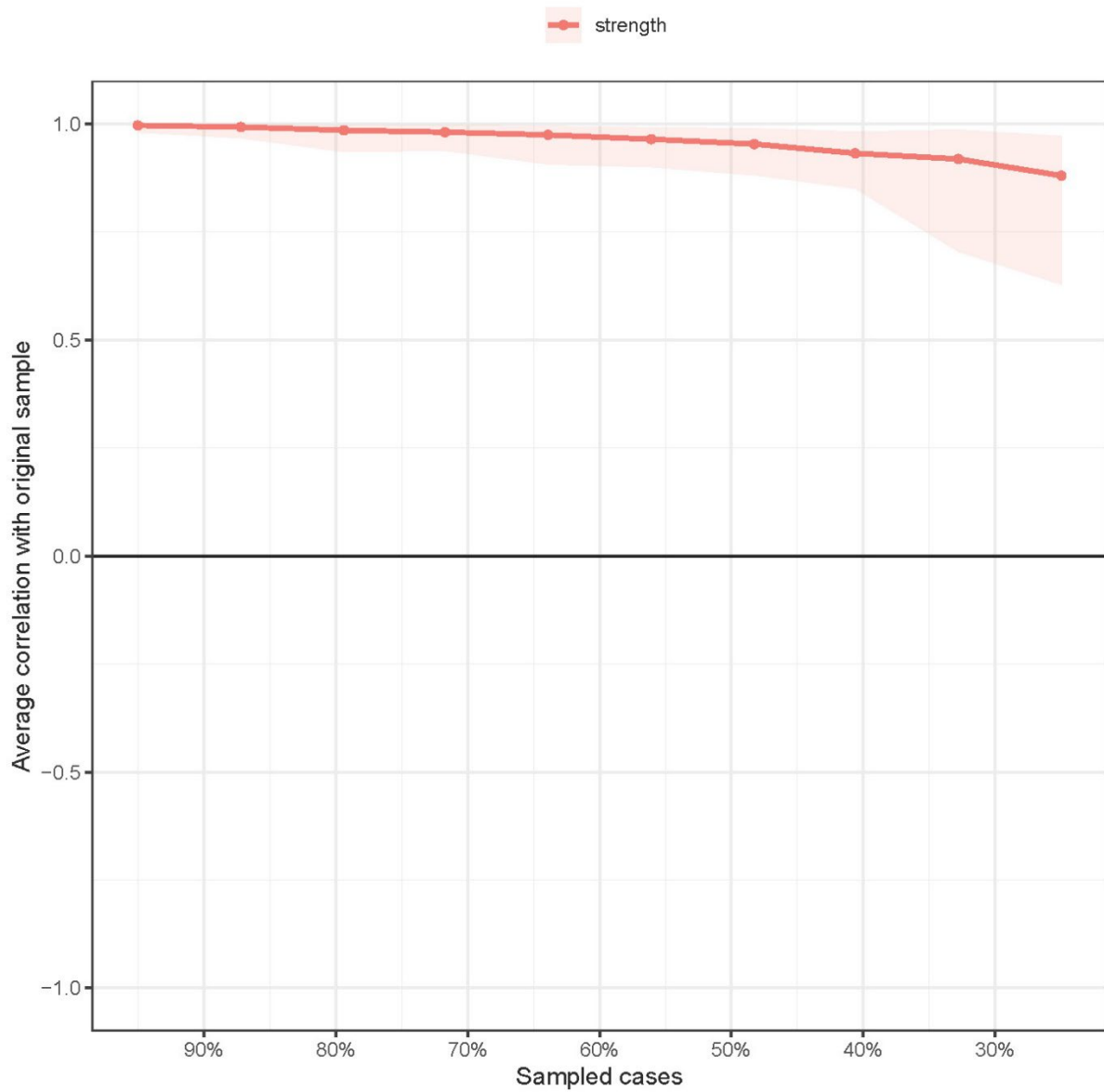
*Bootstrapped Confidence Intervals of Estimated Edge-Weights for the Estimated Network.*



*Note.* The red line indicates the sample values and the black line indicates bootstrapping means. The gray area are the bootstrapped CIs. Each horizontal line represents an edge in the network with edges being ordered from high edge-weight to low edge-weight. Labels on the y-axis are removed to avoid cluttering.

**Figure S2**

*Average Correlations Between Strength Centrality of the Network with a Subset of the Sample and the Original Sample*



*Note.* The line indicates the mean and the area indicates the range from the 2.5th quantile to the 97.5th quantile.

### 3. Overview of Edge Weights

**Table S1**

*Weights Matrix Between the Variables From the Network Analysis*

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Publication Pressure		.21	-.07	-.12	0	0	-.08	-.06	.42	.13	0
2. Work-Home Conflict			-.05	0	0	0	-.01	-.08	.29	.05	.08
3. Autonomy				.02	.17	.13	.04	.0	-.01	0	0
4. Role Clarity					.36	.13	.10	.12	0	.01	0
5. Supervisor Support						.17	0	.06	-.05	0	0
6. Development Opportunities							.11	.03	0	.25	-.02
7. Career Control								.23	-.06	.07	0
8. Psychological Capital									-.17	.23	-.04
9. Burnout										-.35	.03
10. Work Engagement											0
11. Sickness Absenteeism											

*Note.*  $N = 661-665$ . Analyses including sickness absenteeism were based on a smaller subset of the sample ( $N = 267$ ). The edge weights represent the strength of the connection between two nodes, while conditioning on all the other variables in the network model. Thus, the presence of an edge means that there is a relationship between two nodes that cannot be explained by any other node in the network. An absence of an edge means that the two nodes are conditionally independent given the other nodes in the network structure. Positive edge weights indicate positive relationships whereas negative edge weights indicate negative relationships between two nodes. The table includes 38 non-zero edge weights and 16 edge weights that equal zero. For example, the edge weight between publication pressure and supervisor support is zero, indicating that there is no relationship between the two nodes, given the other nodes in the network.

#### 4. Additional References

Burger , J., Isvoranu, A.-M., Lunansky, G., Haslbeck, J., Epskamp, S., Hoekstra, R. H. A.,  
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