



UNIVERSITÀ
DEGLI STUDI
DI MILANO



Conspiracy theories are central to the complex system of predictors of Italian vaccine hesitancy

Arturo Bertero¹

¹Ph.D. Student in Political Science
University of Milan

Wednesday 28th June, 2023

Contents

- 1 Introduction
- 2 Theory
- 3 Methods
- 4 Results
- 5 Discussion
- 6 Conclusions

Network approach in psychometric

“One bird in the flock flies in a particular direction because its neighbouring birds do so; in a latent trait scenario, all birds in the flock fly in a particular direction because of the instructions of an invisible (i.e. latent) bird” (Cramer et al., 2012)



Figure: Flock of birds analogy (Cramer et al., 2012)

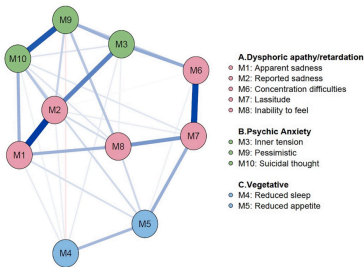


Figure: Symptoms of depression (An et al., 2019)

Network approach in political science

How well does the phrase describe Bill Clinton:

- Lead (L): provides strong leadership
- Care (C): really cares about people like you
- Know (K): knowledgeable
- Done (D): gets things done

Has Bill Clinton ever made you feel:

- Hopeful (H)
- Proud (P)
- Angry (An)
- Afraid (Af)

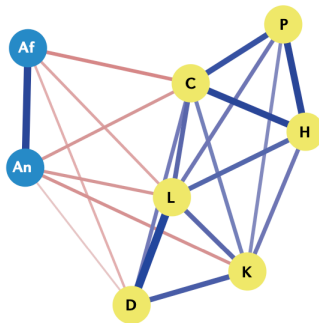


Figure: Attitude network towards Bill Clinton (Borsboom et al., 2021)

Applications of the network approach focused on the measurement of single attitudes and their impact on behavior. Instead, here I investigate the network of predictors of vaccine hesitancy

Vaccine hesitancy in Italy

Relevance

- Vaccines are crucial to react against COVID-19 (Schoch-Spana et al., 2021)
- Vaccine hesitancy as one of the top ten threats to global health (WHO, 2019)

Case selection

- Italian hesitancy rates are among the highest in the world (Sallam, 2021)
- Vaccine hesitancy is extensively studied in Italy (Aw et al., 2021)

Theory

Definition

- “Delay in acceptance or refusal of vaccination *despite the availability* of vaccination services” (MacDonald & SAGE, 2015, p. 4163)

Contextual	Group/individual	Vaccine related
Political inclination: far right	Worry about COVID-19	Belief that vaccines are unsafe
Political inclination: populist	Low risk perception	Opposing to mandatory vaccination
Distrust of institutions	Endorsing conspiracy theories	Concerns about rapid development
Distrust of government	Trust in alternative medicine	Fear of needles
Religiosity	Internal health locus of control	
Digital media diet	Low compliance with COVID-19 preventive behaviors	
Sex, feminine	Distrust of health system	
Lower age	Distrust of science	
Lower education	Lesser sense of collective responsibility	
Lower income		
Living in a Rural region		

Figure: Theoretical predictors of hesitancy worldwide (Aw et al., 2021)

Italian studies

Highly researched

- Twelve peer-reviewed publications
- All theoretical predictors are confirmed in the Italian case

Limitations

- Only three investigated hesitancy conforming to SAGE's definition (Reno et al., 2021; Priori et al., 2021; Ladini and Vezzoni, 2022)
- Reductionist approach

Methods

- **Data:** ResPOnsE data wave three, March 17 - June 16, 2021 (Vezzoni et al., 2020; Biolcati et al., 2021)
- **Variable selection and sample:** inclusion of theoretical predictors only. Listwise deletion: from 3767 to 1540 respondents
- **Empirical expectations:** the network approach will give insights on the often overlooked between-determinant relationships.
 - Hesitancy is the most important node in the complex system of its predictors
 - Hesitancy is only involved in positive linear relationships

Research design

1 Data management

- *Polarity recode*: high values = increased hesitancy
- *PCA*: for compliance with preventive behaviors, disapproval of government and distrust of institutions

2 Network estimation: *mgm* (Haslbeck and Waldorp, 2020)

- Loop of node-wise *LASSO* regressions
- *Tuning parameter* set according to k-fold cross-validation (k=10)
- *Coefficients* are averaged and become edge weights

3 Social network analysis of the network of predictors

- *Walktrap* community detection algorithm (Pons and Latapy, 2005)
- *Strength* and *Degree* centrality (Opsahl et al., 2010)
- *Backbone* reduction (Neal, 2022). Edges are retained if their actual weights are greater than their expected weight in a null model where the total weight of each node is uniformly distributed across its edges

4 Isolate empirical predictors of vaccine hesitancy in Italy

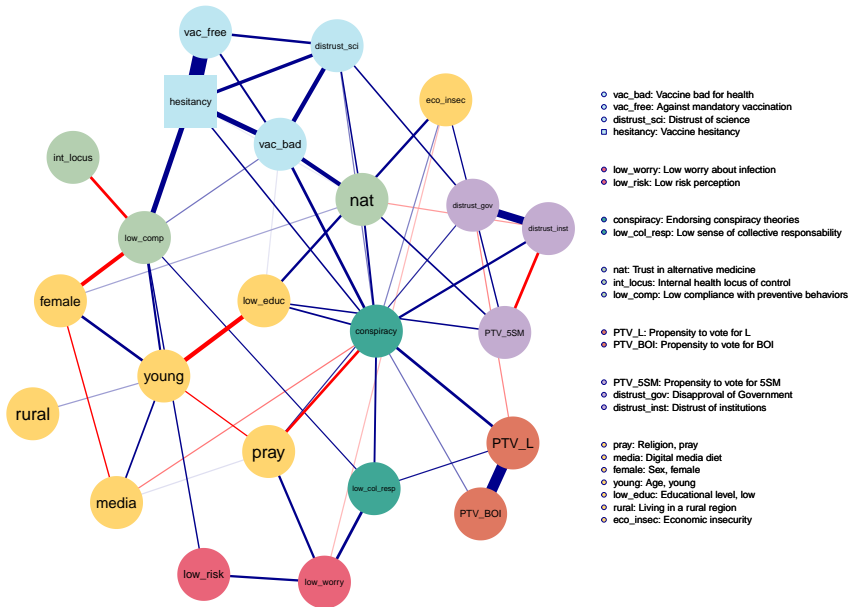
5 Comparison with regression models

Methods

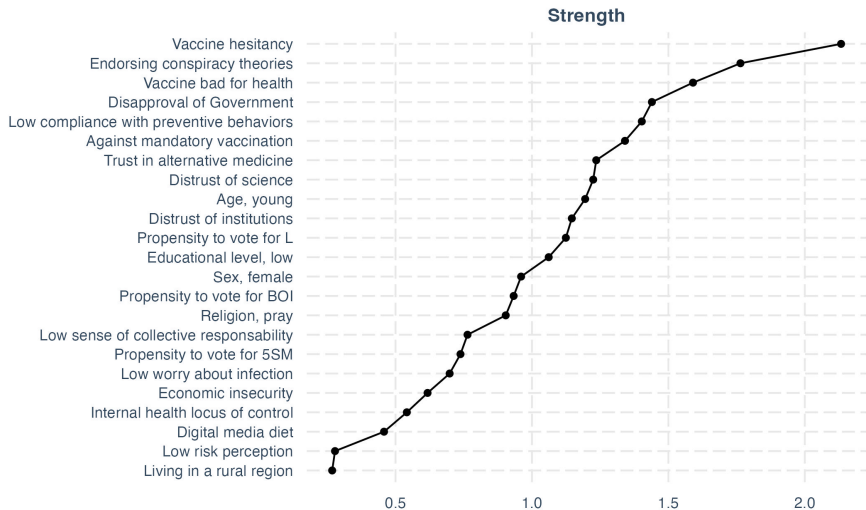
Statistic	Mean	St. Dev.	Min	Max	N
hesitancy	0.2	0.4	0	1	1,540
vac_bad	2.1	1.2	1	5	1,540
vac_free	2.4	1.3	1	5	1,540
low_worry	0.7	0.5	0	1	1,540
low_risk	3.2	0.8	1	5	1,540
conspiracy	0.5	0.5	0	1	1,540
nat	4.1	3.2	0	10	1,540
int_locus	6.5	2.6	0	10	1,540
low_co_resp	4.9	2.6	0	10	1,540
PTV_L	2.6	3.5	0	10	1,540
PTV_SSM	2.7	3.3	0	10	1,540
PTV_BOI	2.5	3.5	0	10	1,540
distrust_sci	2.3	1.2	1	5	1,540
pray	0.6	0.5	0	1	1,540
media	0.5	0.5	0	1	1,540
female	0.5	0.5	0	1	1,540
age+ (young)	47.3	14.9	18	88	1,540
low_educ	0.6	0.5	0	1	1,540
rural	0.4	0.5	0	1	1,540
eco_insec	2.5	0.6	1	4	1,540
low_comp	1.3	1.8	0	10	1,540
distrust_gov	4.4	2.3	0	10	1,540
distrust_inst	5.5	2.5	0	10	1,540

Figure: Descriptives of the selected theoretical predictors

Results



Results



Results



- vac_bad: Vaccine bad for health
- vac_free: Against mandatory vaccination
- distrust_sci: Distrust of science
- hesitancy: Vaccine hesitancy

- low_worry: Low worry about infection
- low_risk: Low risk perception

- conspiracy: Endorsing conspiracy theories
- low_col_resp: Low sense of collective responsibility

- nat: Trust in alternative medicine
- int_locus: Internal health locus of control
- low_comp: Low compliance with preventive behaviors

- PTV_L: Propensity to vote for L
- PTV_BOI: Propensity to vote for BOI

- PTV_5SM: Propensity to vote for 5SM
- distrust_gov: Disapproval of Government
- distrust_inst: Distrust of institutions

- pray: Religion, pray
- media: Digital media diet
- female: Sex, female
- young: Age, young
- low_educ: Educational level, low
- rural: Living in a rural region
- eco_insec: Economic insecurity

Results

Predictor	Edge weight
Against mandatory vaccination	0.95
Vaccine bad for health	0.34
Low compliance with preventive behaviors	0.34
Endorsing conspiracy theories	0.12
Trust in alternative medicine	0.07
Low educational level	0.07

Figure: Empirical predictors of vaccine hesitancy in Italy

Comparing the network approach with other methods

Other methods for multivariate analyses are of course available. But the network approach has some advantages.

- **Regression analysis** can not deal with statistical model of this size
- Unlike **Factor analysis**, partial correlation networks focus on the unique variance shared by each pair of variables
- Being more established, **SEMs** have a wider toolkit, but they rely on a strong theoretical framework

Complementary, not alternative

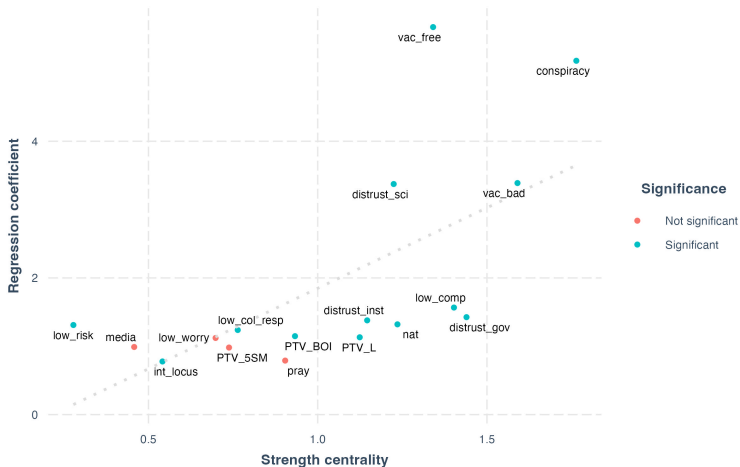


Figure: Strength centrality and regression coefficients (odds ratio). Coefficients are obtained with node-wise *logit* (DV = hesitancy; C = sex, age, educ, reg, economic insecurity)

Complementary, not alternative

Variable	Strength	Coefficient	Edge weight
Endorsing conspiracy theories	1.46	1.06	0.07
Vaccine bad for health	0.76	0.13	1.89
Against mandatory vaccination	-0.23	1.32	0.07
Trust in alternative medicine	-0.65	-0.96	-0.58
Low compliance with preventive behaviors	0.01	-0.83	-0.73
Low educational level	-1.35	-0.72	-0.73

Figure: Comparison of Strength, Regression Coefficient, and Edge Weight of theoretical predictors (Z-scores)

Conclusions

- **Empirical contributions**

- ① Empirical predictors of vaccine hesitancy in Italy
- ② Conspiracy theories are central to the complex system of predictors of Italian vaccine hesitancy

- **Methodological contributions**

- ① First application of the complex system approach to the study of Italian hesitancy
- ② Theory-driven variable selection

- **Limitations**

- ① Cross-sectional data do not give insight on causality
- ② List-wise deletion
- ③ Network analysis depends on variable selection, which was deficient

Thank you!

arturo.bertero@unimi.it

References

- Cramer, A. O., Van der Sluis, S., Noordhof, A., Wichers, M., Geschwind, N., Aggen, S. H., & Borsboom, D. (2012). Dimensions of normal personality as networks in search of equilibrium: You can't like parties if you don't like people. *European Journal of Personality*, 26(4), 414-431.
- An, M. H., Park, S. S., You, S. C., Park, R. W., Park, B., Woo, H. K., ... & Son, S. J. (2019). Depressive symptom network associated with comorbid anxiety in late-life depression. *Frontiers in Psychiatry*, 10, 856.
- Borsboom, D., Deserno, M. K., Rhemtulla, M., Epskamp, S., Fried, E. I., McNally, R. J., ... & Waldorp, L. J. (2021). Network analysis of multivariate data in psychological science. *Nature Reviews Methods Primers*, 1(1), 58.
- Schoch-Spana, M., Brunson, E. K., Long, R., Ruth, A., Ravi, S. J., Trotochaud, M., Borio, L., Brewer, J., Buccina, J., Connell, N., Hall, L. L., Kass, N., Kirkland, A., Koonin, L., Larson, H., Lu, B. F., Omer, S. B., Orenstein, W. A., Poland, G. A., White, A. (2021). The public's role in COVID-19 vaccination: Human-centered recommendations to enhance pandemic vaccine awareness, access, and acceptance in the United States. *Vaccine*, 39(40), 6004–6012. <https://doi.org/10.1016/j.vaccine.2020.10.059>
- WHO, (World Health Organization) 2020: Ten threats to global health in 2019. Retrieved from: <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>
- Aw, J., Seng, J. J. B., Seah, S. S. Y., & Low, L. L. (2021). COVID-19 Vaccine Hesitancy — A Scoping Review of Literature in High-Income Countries. *Vaccines*, 9(8), 900. <https://doi.org/10.3390/vaccines9080900>
- Sallam, M. (2021). COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. *Vaccines*, 9(2), 160. <https://doi.org/10.3390/vaccines9020160>
- MacDonald, N. E., & SAGE Working Group on Vaccine Hesitancy. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, 33(34), 4161–4164
- Reno, C., Maietti, E., Fantini, M. P., Savoia, E., Manzoli, L., Montalti, M., & Gori, D. (2021). Enhancing COVID-19 Vaccines Acceptance: Results from a Survey on Vaccine Hesitancy in Northern Italy. *Vaccines*, 9(4), 378. <https://doi.org/10.3390/vaccines9040378>

References

- Priori, R., Pellegrino, G., Colafrancesco, S., Alessandri, C., Ceccarelli, F., Franco, M. D., Riccieri, V., Scrivo, R., Scavalli, A. S., Spinelli, F. R., & Conti, F. (2021). SARS-CoV-2 vaccine hesitancy among patients with rheumatic and musculoskeletal diseases: a message for rheumatologists. *Annals of the Rheumatic Diseases*, 80(7), 953–954. <https://doi.org/10.1136/annrheumdis-2021-220059>
- Ladini, R., & Vezzoni, C. (2022). When Believing in Divine Immanence Explains Vaccine Hesitancy: A Matter of Conspiracy Beliefs? *Politics and Governance*, 10(4). <https://doi.org/10.17645/pag.v10i4.5766>
- Vezzoni, C., Ladini, R., Molteni, F., Dotti Sani, G. M., Biolcati, F., Chiesi, A., Maraffi, M., Guglielmi, S., Pedrazzani, A., & Segatti, P. (2020). Investigating the social, economic and political consequences of Covid-19: A rolling cross-section approach. *Survey Research Methods*, 14(2), 187-194. DOI:10.18148/srm/2020.v14i2.7745
- Biolcati, F., Vezzoni, C., Ladini, R., Chiesi, A.M., Dotti Sani, G.M., Guglielmi, S., Maggini, N., Maraffi, M., Molteni, F., Pedrazzani, A., Segatti, P. (2021), Come monitorare la risposta dell'opinione pubblica a eventi imprevisi? Il progetto ResPOnsE COVID-19, *Polis*, 35(1): 165-178. DOI: 10.1424/100292.
- Haslbeck, J. M. B., & Waldorp, L. J. (2020). mgm : Estimating Time-Varying Mixed Graphical Models in High-Dimensional Data. *Journal of Statistical Software*, 93(8). <https://doi.org/10.18637/jss.v093.i08>
- Pons, P., & Latapy, M. (2005). Computer and Information Sciences - ISCIS 2005, 20th International Symposium, Istanbul, Turkey, October 26-28, 2005. *Proceedings. Lecture Notes in Computer Science*, 284–293. https://doi.org/10.1007/11569596_1
- Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social networks*, 32(3), 245-251.
- Neal, Z. P. (2022). backbone: An R package to extract network backbones. *PLoS ONE*, 17(5), e0269137. <https://doi.org/10.1371/journal.pone.0269137>

Methods

Name	Question	Scale
Vaccine hesitancy	Obtained combining: "Have you already received the COVID-19 vaccine?", "What is your intention regarding the administration of the COVID-19 vaccine?"	0 (not hesitant) to 1 (hesitancy)
Vaccine bad for health	Vaccines wear down the immune system and expose it to various diseases	1 (disagree) to 5 (agree)
Against mandatory vaccination	Vaccination against COVID-19 must be compulsory for everyone.	1 (disagree) to 5 (agree)
Low worry about infection	In the last 7 days, have you been concerned about the possible consequences of the Coronavirus for your health?	0 (less than three times) to 1 (three times or more in a week)
Low risk perception	Do you personally feel that you are more or less exposed to contagion than the majority of the population in your area?	1 (more) to 5 (less exposed)
Endorsing conspiracy theories	What do you think is the most likely origin of the virus?	0 (transition from animals to humans) to 1 (US-China war for world supremacy, Wrong scientific experiments)
Trust in alternative medicine	More space should be given to natural healing methods	0 (disagree) to 10 (agree)
Internal health locus of control	How much do you think Italians with their own behaviors are responsible for the pandemic's course?	0 (not responsible) to 10 (responsible)
Low sense of collective responsibility	Faced with the Coronavirus crisis, governments may react in different ways. A government may prioritize reducing Coronavirus infections, even at the cost of causing a serious economic crisis for the country. Or a government may prioritize defending the national economy, even at the cost of increasing the number of infections. Where would you place your opinion?	0 (health) to 10 (economy as a priority)
Propensity to vote for L	Among the various parties we have in Italy, each would like to have your vote in the future. Regardless of how you plan to vote in the next election, how likely are you to vote for the League in the future?	0 (not likely) to 10 (likely)
Propensity to vote for 5SM	Among the various parties we have in Italy, each would like to have your vote in the future. Regardless of how you plan to vote in the next election, how likely are you to vote for the Five Star Movement in the future?	0 (not likely) to 10 (likely)
Propensity to vote for BOI	Among the various parties we have in Italy, each would like to have your vote in the future. Regardless of how you plan to vote in the next election, how likely are you to vote for Brothers of Italy in the future?	0 (not likely) to 10 (likely)
Distrust of science	When it comes to vaccines, the recommendations of the scientific community can be trusted	0 (agree) to 5 (disagree)
Religion, pray	In the last week, how often did you pray?	0 (never) to 1 (more than -or once a -day, more than -or once a -week)
Digital media diet	Mainly, where do you get the most information about the Coronavirus crisis from?	0 (non-digital media) to 1 (digital media)
Sex, female	Could you report your sex?	0 (man) to 1 (female)
Age, young	Could you report your age?	88 (min) to 18 (max)
Education level, low	Could you report your educational level?	0 (more than high school) to 1 (less than high school)
Living in a rural region	Could you indicate how many people reside in your township?	0 (more than 30K) to 1 (less than 30K)
Economic insecurity	Your household's income allows you to live...	0 (comfortably, easily) to 1 (with some difficulties; we don't make ends meet)
Low compliance with preventive behaviors	Obtained combining: To what extent do the following sentences correspond to your behavior over the past seven days? "I stayed at least three feet away from other people", "I wore a mask and/or gloves", "I washed and sanitized my hands often"	0 (high) to 10 (low compliance)
Disapproval of Government	Obtained combining: "What is your assessment of the measures imposed by the government to stop the spread of COVID-19?", "How do you assess the actions of the Draghi government during the COVID-19 emergency?"	0 (positive) to 10 (negative evaluation)
Distrust of institutions	Obtained combining: What degree of trust do you give to the following institutions? "The Italian parliament", "The European Union"	0 (low) to 10 (high trust)

