

How schools affect the well-being of 15-year-old Italian students

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Applied Statistics - Mathematical Engineering

Objective

The present study aims to identify the cognitive, psychological, social, physical, and material components that significantly affect the well-being of Italian students and to estimate the magnitude of school effects on their health and comfort. Data comes from Italian PISA 2018 data set, comprising of 11785 students enrolled in 542 schools.

Preliminary analysis

A first selection of the indices is supported by the construction of a network structure (Figure 1), which explains the relation and the importance of each variable with respect to the others in terms of correlation [2]. Shorter bonds and intense colors are associated with greater correlations. Therefore, it is possible to highlight groupings of variables associated with the performance in the tests and those associated with students' perception of teaching methods.

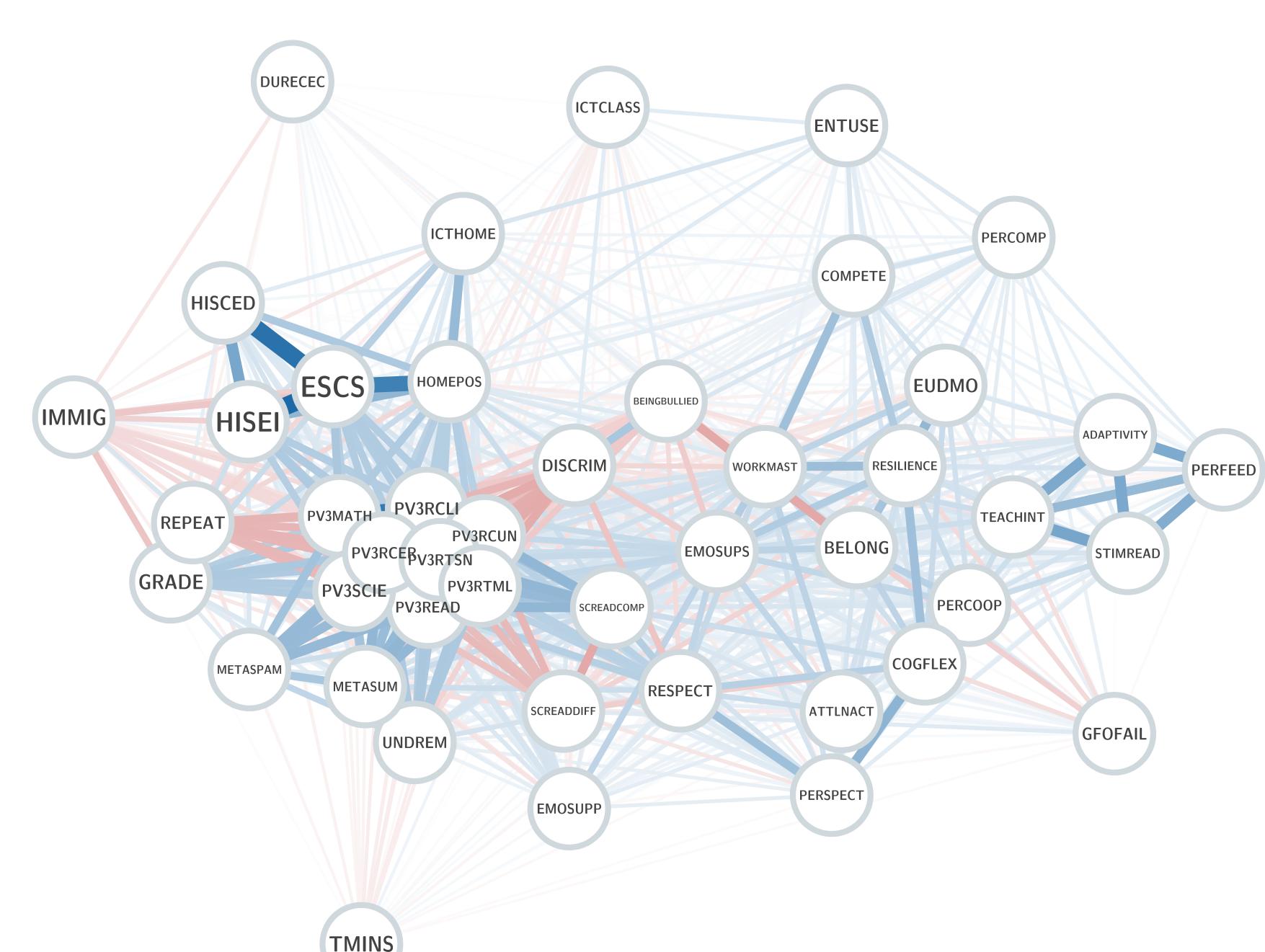


Figure 1: Graph built via network analysis, based on the covariance structure of the data.

The latent factors

To reduce the dimensionality and describe the covariance structure among the indices in terms of a few unobserved latent variables, a factor analysis of the data is performed [4]. The outcome of the method suggests the presence of three main factors, later referred to as “Performance”, “Well-being” and “Teaching”. The first represents the test scores of the student, the second estimates their well-being status and the third measures how the teaching methods are perceived by the student.

A model for Well-being

To address the complexity of the phenomenon, we followed a flexible approach. The relationship between “Well-being” and the other variables is described with a random forest with 500 trees [3].

The significant variables are the students' perception of teaching (Teaching), the perceived competitiveness (Compete) and their attitude towards learning activities (Attlnact), highlighting their critical role in explaining students' well-being (Figure 2). The discriminating climate of the school (Discrim), the performances at the tests (Performance) and the emotional support of the parents (Emosupp) also play a major role.

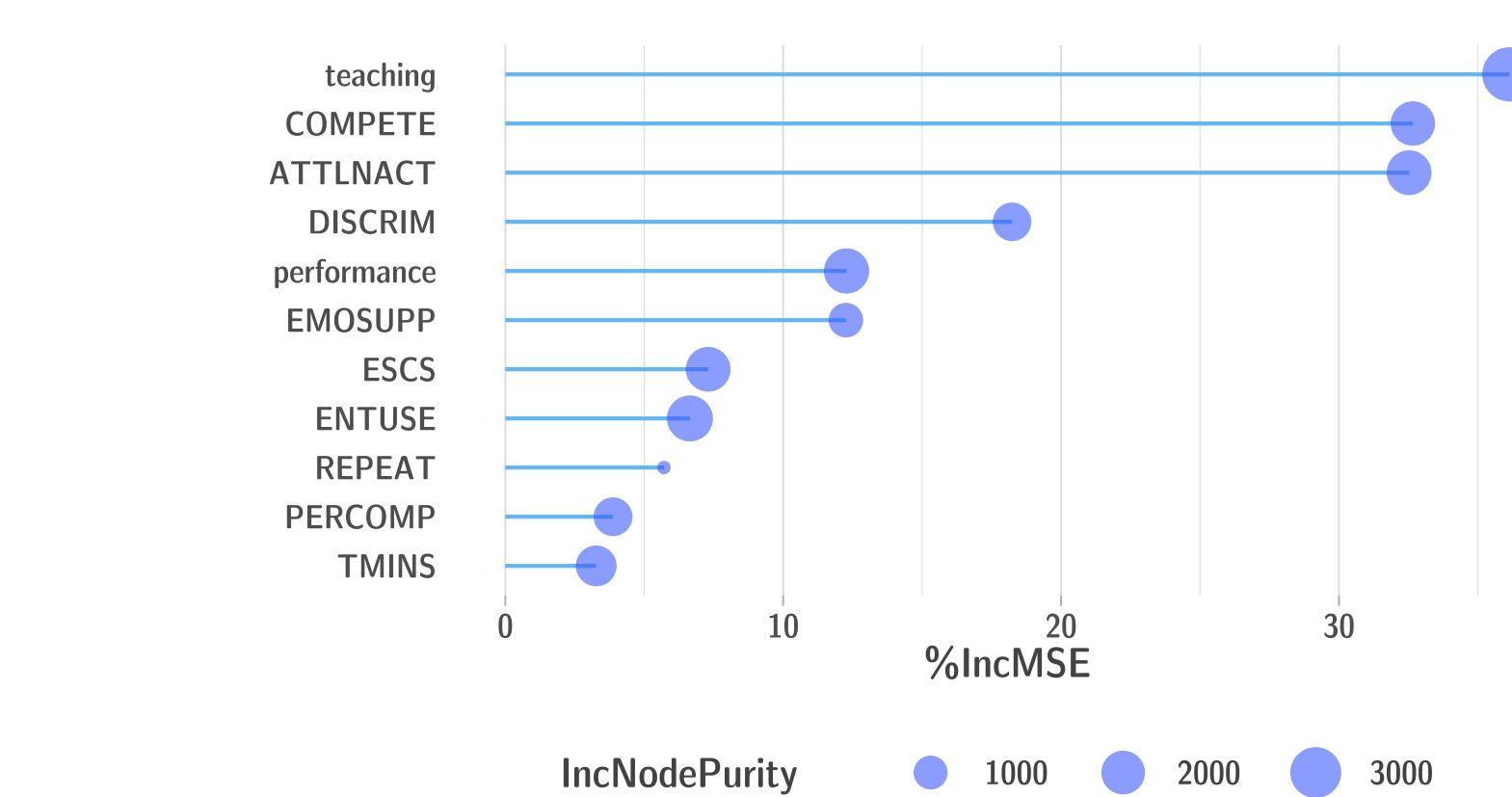


Figure 2: Importance of the variables in the random forest model considering the percent increase in MSE and the node purity.

The partial plots in Figure 3 depict the marginal effect of the most important variables on the response, where the importance is measured in terms of percent increase in MSE. We can observe quadratic relations between the response and “Teaching”, “Compete” and “Attlnact”. Moreover we notice a strongly non-linear association between the response and "Discrim", highlighting a ceiling and floor effect.

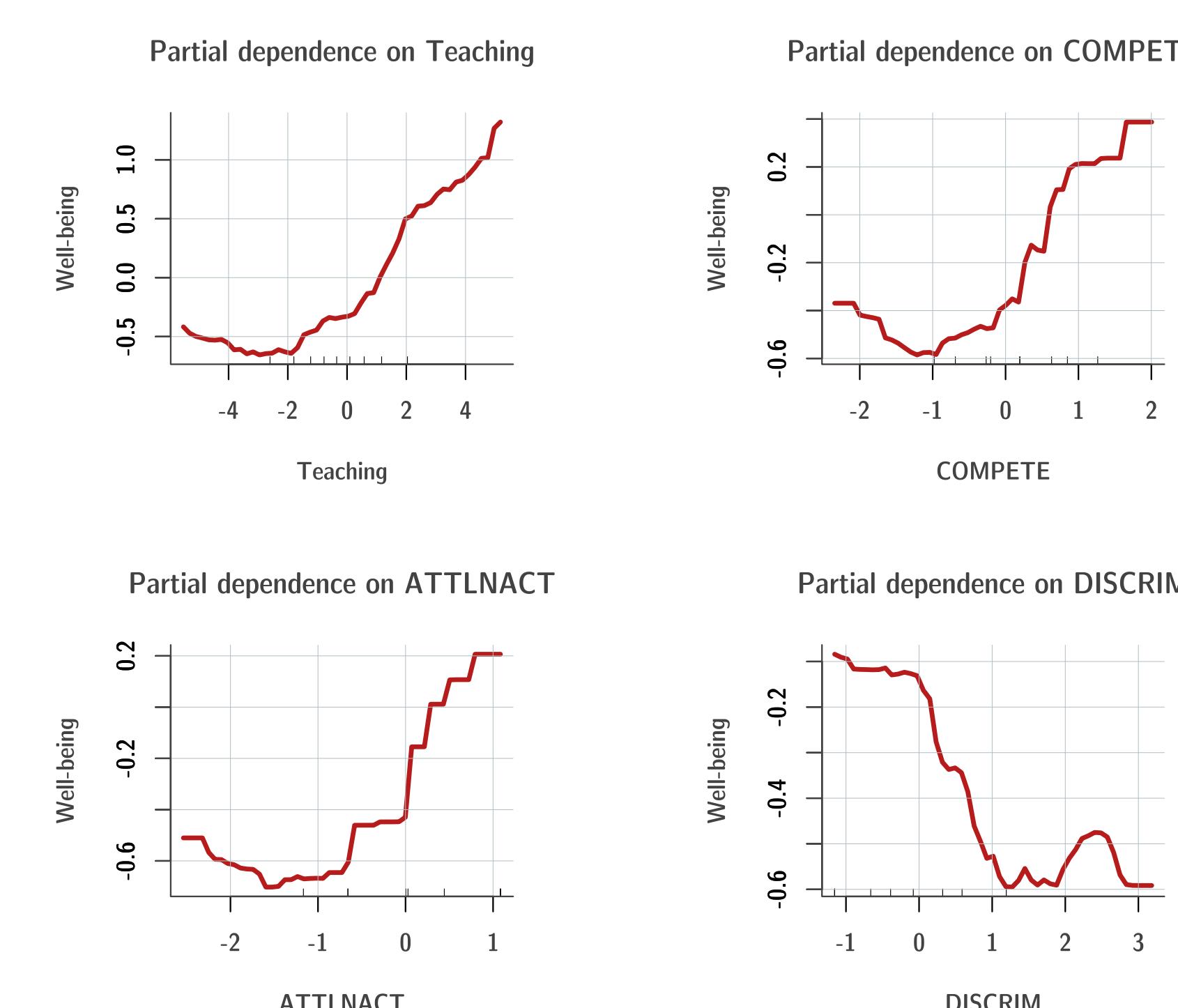


Figure 3: Partial dependence of Well-being on the variables
Teaching, Compete, Attlnact and Discrim in the random forest model

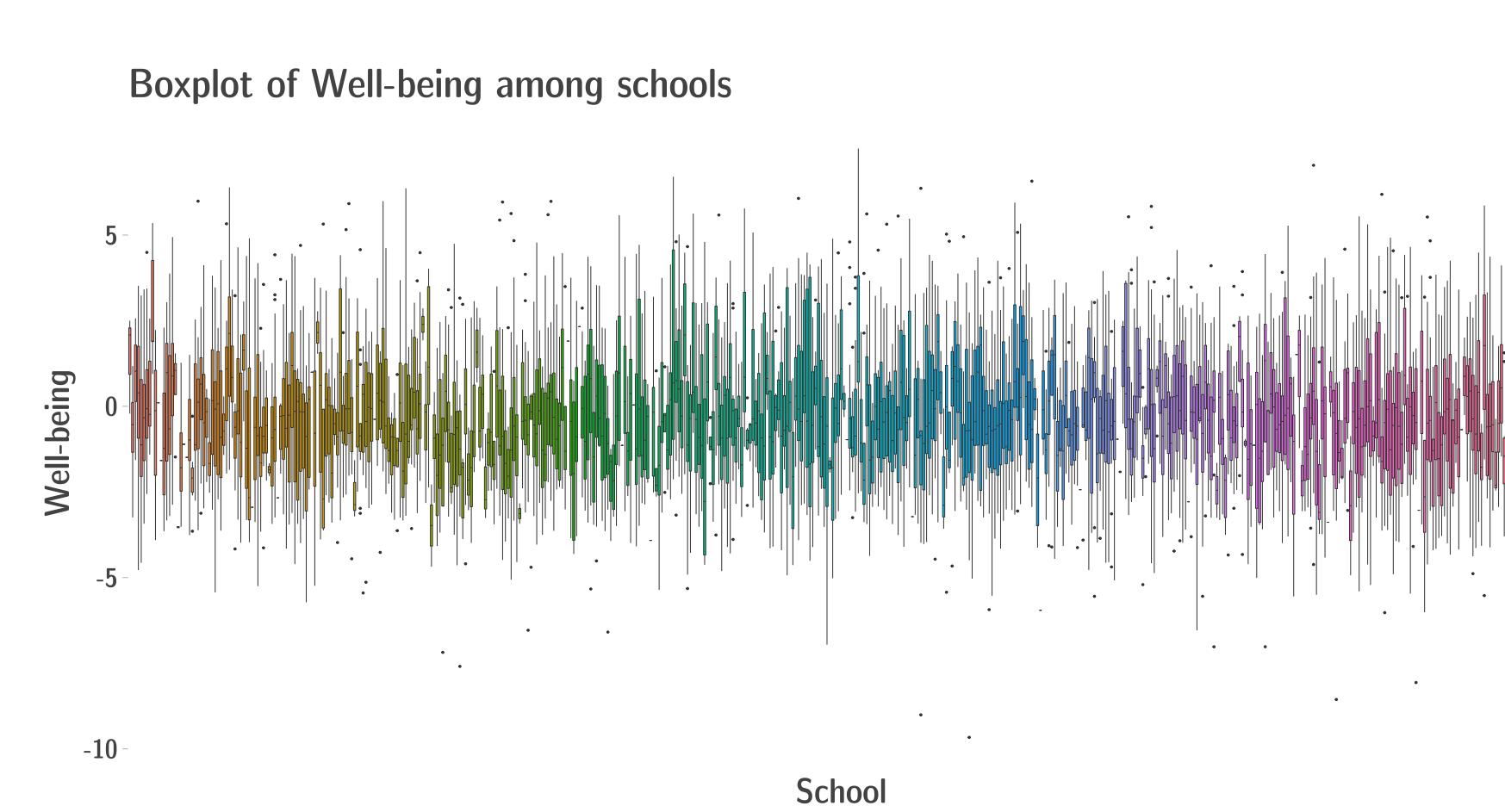


Figure 4: Boxplot of Well-being across schools.

The school effect

The boxplot in Figure 4 shows significant variability among the well-being across schools and hints to a model that considers the membership to the institute. Therefore, we built a linear mixed model with “Well-being” as response, a fixed intercept and a random intercept associated to the school ($PVRE=0.0551$). The model allows to group the schools as above, below or on average with respect to their effect on students’ well-being.

The estimated school effect is then introduced as the outcome variable of a multinomial logistic model [1]. The regressors are selected from an additional school related dataset. The results show how above average schools are characterized by more disciplined students, while the shortage of educational staff and bigger classes affect below average schools. On the other hand, the availability of creative extra-curricular activities does not seem to be a significant factor of differentiation.

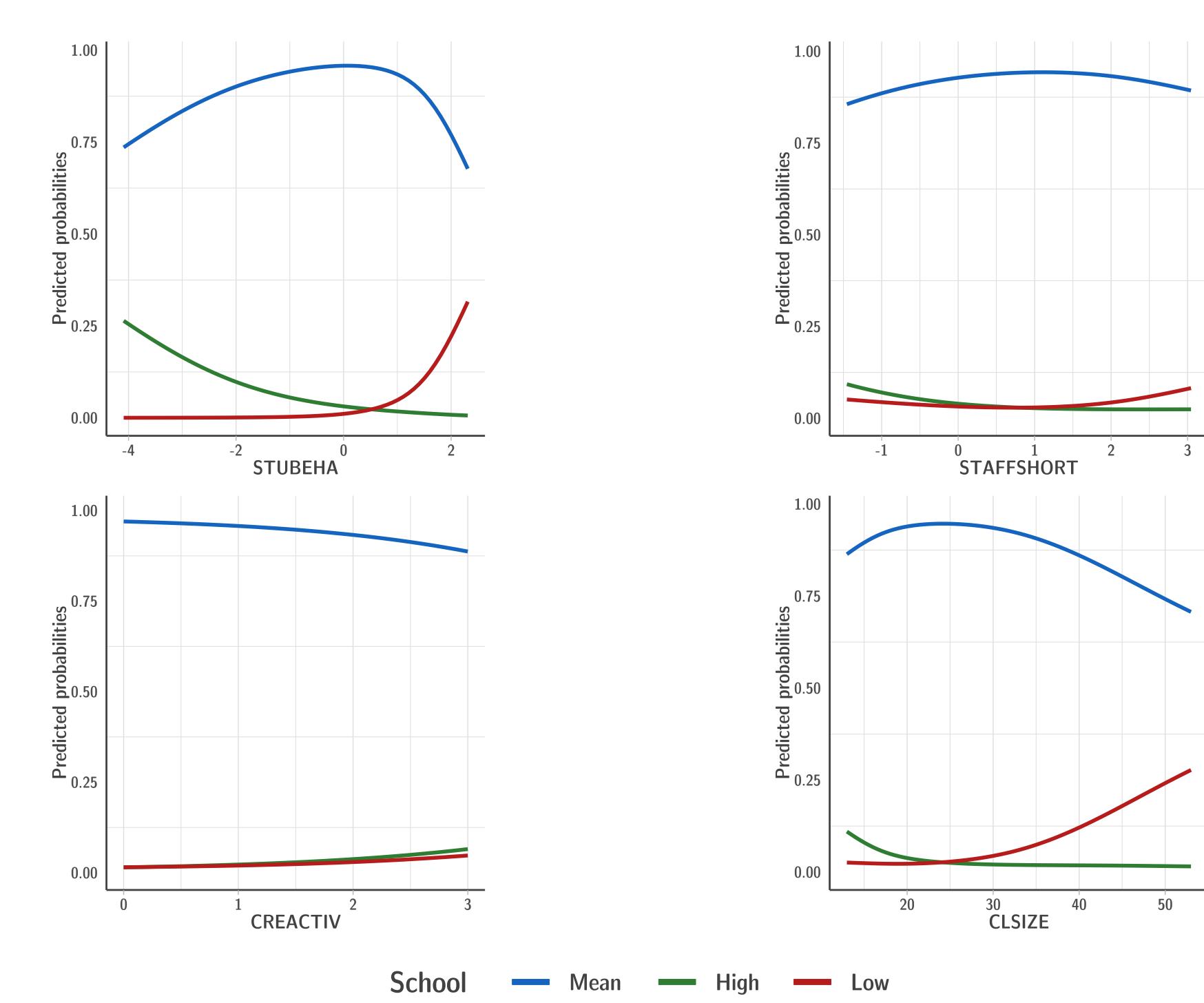


Figure 5: Predicted probabilities of the school level with respect to Stübeha, Staffshort, Creactiv and Clsize

Conclusions

Our findings reveal a clear relationship between students' well-being and a careful management of teaching aspects, both at student and school level. Behavioral discipline and a bit of healthy competitiveness seem also to ease the climate. Possible welfare policies should focus on improving teachers' proficiencies in managing the dynamics of the class. Future continuations of this study may consider the incoming 2022 data for a post-Covid assessment and expand the analysis to a broader set of countries.

References

- [1] S. L. R. X. S. David W. Hosmer, Jr. *Applied Logistic Regression*. John Wiley Sons, Inc., 2013.
 - [2] E. Govorova, I. Benítez, and J. Muñiz. Predicting student well-being: Network analysis based on pisa 2018. 17, June 2020.
 - [3] J. F. Trevor Hastie, Robert Tibshirani. *The Elements of Statistical Learning*. Springer New York, NY, 2009.
 - [4] M. W. Watkins. Exploratory factor analysis: A guide to best practice. 44(3):219–246, 2018