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Traditional Gender Role Attitudes in Science, Technology, Engineering, and Mathematics (STEM): Are STEM Managers More Modern Than Others?

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ABSTRACT

The lack of women in Science, Technology, Engineering, and Mathematics (STEM) careers is a multifaceted problem, and there may be various levers for change (e.g., managers' attitudes). Whereas most previous studies have focused on educational aspects, we targeted later career stages: We measured managers' gender role attitudes because managers can be a source of support or discrimination. In fact, women in STEM fields report less support and more discrimination than STEM men or non-STEM women do. Using a large and representative data set from the Socio-Economic Panel (SOEP) in Germany, we compared traditional gender role attitudes in STEM versus non-STEM fields with ordered probit regressions and a multiverse analysis. We found that male, older, non-managerial, and non-STEM employees had more traditional gender role attitudes than others. Additionally, we found a gender gap: For men, older employees had more traditional gender role attitudes; for women, age did not matter, but female managers had less traditional gender role attitudes than non-managers. Reasons for this trend might be selection (e.g., women with traditional attitudes might abandon their careers earlier) or socialisation (e.g., female managers' attitudes may change in male-dominated environments). Implications for women's careers are discussed.

KEYWORDS

STEM; traditional gender role attitudes; panel study; manager; SOEP

Traditional Gender Role Attitudes in Science, Technology, Engineering, and Mathematics (STEM): Are STEM Managers More Modern Than Others?

INTRODUCTION

The lack of women in STEM (Science, Technology, Engineering, and Mathematics) careers is a multifaceted problem with various levers (Blickenstaff, 2005). Besides the women in STEM themselves, various other people are involved in the pipeline through which women enter STEM (e.g., parents, teachers, supervisors, managers). It was shown that perceived stereotypes lead women to consider dropping out of STEM careers (Clark et al., 2021), and an analysis of many reasons for the low retention rates of women in STEM jobs still showed unexplained variance (Glass et al., 2013). In a study of STEM-typical competencies rather than roles or attitudes, Glass and colleagues (2013) suggested that additional factors such as traditional attitudes of coworkers and supervisors could be relevant, as they may result in experiences of discrimination for women in STEM.

Theoretical background

Women in STEM fields tend to report more negative experiences than others. For example, STEM women were found to perceive their organisations as less supportive than STEM men and reported experiencing a larger amount of discrimination than both STEM men and non-STEM women (Blackwell et al., 2009).

One reason for such discrepancies could be the general gender imbalance in STEM combined with more traditional attitudes[1] of men in general. Less than 17% of the German STEM[2] workforce consisted of women in 2021 (Bundesagentur für Arbeit, 2023), and only 24% of the UK STEM workforce consisted of women in 2019 (Statista Search Department, 2023). In the U.S., 27% of the STEM workforce in 2019 were women (Martinez & Christnacht, 2021). Traditional gender role attitudes have been found to be more pronounced among men than among women (Brewster & Padavic, 2000; Toh & Watt, 2022). These include, for example, the attitudes that it is better for everyone if the woman takes care of the household, or that preschool-age children are likely to suffer if their mothers work outside the home (Toh & Watt, 2022). Overall, more men work in STEM, and men in general have more traditional gender role attitudes than women do.

We see two processes that apply specifically to men pursuing STEM careers up to the management level. The first is (self-)selection: Past research showed that male STEM students are more likely to believe that men are better than women in mathematics, sports, navigation, and construction in comparison to female STEM students and male non-STEM students (Moè et al., 2021). Moreover, men with more traditional gender role attitudes more frequently ended up in STEM fields than other men with less traditional attitudes (Sassler et al., 2017). Even though this finding does not speak to causality, it may indicate that stereotypes and traditional attitudes play a role in both study and career choices among men. However, as society is changing rapidly (Mohajan, 2022), such attitudes may have shifted towards greater gender equality.

The second process is a lack of socialisation due to STEM men's lack of exposure to female colleagues, which ties into the argument that men are self-selected into STEM jobs: Men who do not work with women on a daily basis might not consider the problems of discrimination and stereotyping an issue. Given the abovementioned small percentages, women are a minority in STEM fields, and men in such fields do not encounter many women in their daily work lives. For a similar logic, see the argument of the female socialisation hypothesis in research on the so-called daughter effect: Fathers are especially likely to become more sensitive to gender inequity through the experiences a daughter shares with them (Shafer & Malhotra, 2011). If men do not have a daughter, they may miss out on the opportunity to become more sensitive to gender inequity. Similarly, if men are not in contact with female employees in their daily work environment, they might not have the opportunity to become more sensitive to gender inequity in the workplace. Such processes may be reinforced over the years in a STEM career on the way to a management position.

STEM-specific selection and socialisation processes apply not only to men in STEM but also to women. However, such processes may have different outcomes for women.

The first possibility is (self-)selection: Women with traditional gender role attitudes may follow their ideas about which occupations offer a good fit for women and might therefore not choose STEM occupations. Research at the (pre-)college stage showed that women with traditional gender role attitudes at age 16 or 18 were less likely to work in STEM occupations than in other occupations (Dicke et al., 2019). In fact, stereotypes regarding women's high emotionality, lack of ability to have a science career, and low math competencies have been found to be less pronounced in college women studying STEM subjects than in women studying other subjects (see Dunlap & Barth, 2019; Smeding, 2012). These differences may still persist, and when women get promoted to management positions, this discrepancy may perpetuate.

However, there is a second possibility. It is possible that low numbers of women in STEM may promote the queen bee phenomenon: Women pursuing a career in a male-dominated work environment tend to assimilate to the male culture and may distance themselves from other women (Ellemers et al., 2012; Staines et al., 1974). One consequence of this phenomenon is that "queen bees" might perpetuate stereotypes in the organisation (Derks et al., 2016). Thus, women in STEM may hold more traditional attitudes than those in other fields.

The present study

Our contribution to the literature is the following: First, we focus on a later stage in women's careers than previous research. There is already ample research on the relationship between STEM-related stereotypes held by parents and teachers and women's decisions to major in STEM fields (e.g., Ikkatai et al., 2019), as well as women's performance and interest in STEM fields (Gunderson et al., 2012). We aim to shed light on a later stage by asking: "Do managers hold stereotypes that may act as a barrier to women's careers?" Second, we focus on managers. In a previous study, male STEM managers tended to be more implicitly gender biased in their hiring decisions than female STEM managers (Friedmann & Efrat-Treister, 2023). As managers are people who contribute significantly to their employees' careers (e.g., through selection/promotion), their attitudes are a potential barrier that is exogenous to the women themselves. Thus, we focus on this exogenous factor to reduce barriers in women's STEM careers. Third, we focus on quantitative comparisons between STEM and non-STEM fields, whereas previous studies have primarily identified barriers on the basis of qualitative studies and have not addressed potential differences between STEM and non-STEM fields (e.g., Chapple & Ziebland, 2018). Quantitative studies can help us understand the strength of associations in addition to their existence. Thus, we provide effect sizes to advance an overview of associations between STEM, gender, and traditional gender role attitudes.

Building on our literature review, we tested the following hypotheses:
H1) In STEM managers, traditional gender role attitudes are more pronounced than in non-STEM managers.
H2) In male managers, traditional gender role attitudes are more pronounced than in female managers.
H3) In male non-STEM managers, traditional gender role attitudes are less pronounced than in male STEM managers.
H4) Traditional gender role attitudes differ between female STEM and non-STEM managers.

METHOD

Data set

The study's data came from the German Socio-Economic Panel (SOEP). The multicohort panel study relies on a survey administered to over 30,000 people each year. We focussed on two of the waves of data that were collected once per year in 2017 and 2018, released as part of the latest available data set (Giesselmann et al., 2019; DOI: https://doi.org/10.5684/soep.core.v37eu). All the variables we retrieved are listed in Appendix A. Special protections apply to personal data in Europe; thus, the publication of SOEP data is prohibited. However, access to the data is granted to researchers via https://www.diw.de/documents/dokumentenarchiv/17/diw_01.c.88926.de/soep_application_contract.583953.pdf.

Participants

The SOEP does not ask the same questions every year, so data from different waves were needed to select participants. Most of the data we used came from the 2018 wave. We determined management status using the previous year's data because this information was not collected in 2018. Therefore, we were able to include only individuals who did not change jobs in the meantime and were part of the SOEP sample in 2017 and 2018. Thus, the total sample size was N = 10,101, including N = 2,917 managers and N = 7,184 non-managers. We classified participants as managers if they were in a supervisory position and had at least two employees reporting to them. In the manager subsample, we found 12.3% working in STEM (non-manager sample: 9.0%) and 37.4% women (non-manager sample: 57.1%). More detailed sample sizes are attached in Appendix B.

By applying cross-sectional weights, our results were representative of the German population (Goebel et al., 2019).

Measures

Traditional gender role attitudes

The three-item scale for traditional gender role attitudes had already been used by Hamjediers (2021). The items were (a) "Children under age 6 suffer when their mother works," (b) "Children under age 3 suffer when their mother works," and (c) "It is best for the husband and wife to work equally so that they can share family and household responsibilities equally" (reverse coded). In our manager sample, the scale had a Cronbach's alpha of .64 (N = 2,917). In the total sample, including non-managerial employees, the scale had a Cronbach's alpha of .61 (N = 10,101).

STEM versus non-STEM

We coded the current occupations as STEM or non-STEM. The SOEP provides information on occupations on the basis of the International Standard Classification of Occupations (International Labour Office, 2012). The coding rules (see the Electronic Supplementary Materials ESM 1) we developed were based on the definition of STEM from the Standard Occupational Classification System (SOC; the definition of STEM can be found here: https://www.bls.gov/soc/Attachment_B_STEM.pdf). Because, to the best of our knowledge, there is no existing way to match the SOC and the ISCO-08 on the most detailed occupation level, we defined the coding rules (as attached to the preregistration) on the basis of the SOC STEM definition and applied the rules to the ISCO-08 system. The first author coded all 436 occupation groups of the ISCO-08 (for the results of the coding, see Electronic Supplementary Materials ESM 2), and 10% of the material was independently coded by a second coder. Interrater reliability was 100% (Cohen's kappa).

Control variable: Age

In general, younger people have less traditional gender role attitudes (Lynott & McCandless, 2000; Sweeting et al., 2014). Age is also related to job experience and therefore to the likelihood of being a manager. As age is correlated with both the dependent and independent variables, we included it as a covariate.

Analyses

Software

Our analyses were computed with the R software version 4.0.2 (R Core Team, 2020). Additionally, we used the following packages: apaTables (Stanley, 2021), brant (Schlegel & Steenbergen, 2020), lubridate (Grolemund & Wickham, 2011), MASS (Venables & Ripley, 2002), psych (Revelle, 2022), radiant.data (Nijs & von Hertzen, 2023), rstatix (Kassambara, 2021), sensemakr (Cinelli et al., 2021), stargazer (Hlavac, 2022), tidyverse (Wickham et al., 2019), Weighted.Desc.Stat (Parchami, 2016), and weights (Pasek et al., 2021). We preregistered the plans for our analyses (see https://osf.io/65ztp/?view_only=8511f2e4001c47acb04e0e0c8a3a4428). The following adaptations were made to our preregistration: First, at the suggestion of a reviewer, we have combined two competing pre-registration hypotheses into what is now the new Hypothesis 4. Second, we have added additional methods of analysis to the preregistered ordered probit regression, resulting in a multiverse analysis which ensures the robustness of our results. The final analysis code can be found in the Electronic Supplementary Materials ESM 3.

Multiverse analysis
Traditional gender role attitudes were assessed with a Likert scale, and thus, ordinal data. Ordered probit regression models based on the median were computed (similar to Leder et al., 2021). We found unequal sample sizes between the STEM and non-STEM groups as well as between the female and male managers as a result of the different sizes of the groups in the population. Such differences can affect the statistical power. We applied a post hoc analysis of the statistical power and verified our analyses with different statistical methods (i.e., multiple linear regression, ordered probit regression based on the mean, ANCOVA) in the style of a multiverse analysis (Steegen et al., 2016) to determine whether the results converged.

Models to test hypotheses
To test H1, we ran a basic Model 1 with STEM versus non-STEM as the independent variable and traditional gender role attitudes as the dependent variable, controlling for the variable age. To test H2, we added gender as a second independent variable to the first model to create Model 2. To test H3, we ran Model 3, which was the same as Model 1, but it was tested on an adjusted sample consisting of male managers only. To test H4, we ran Model 4, which was the same as Model 1, but it was tested on an adjusted sample consisting of female managers only. We also ran unstandardised versions of each model, without the covariate and unweighted. The full results of our multiverse analysis (Steegen et al., 2016) as well as an overall moderation analysis are reported in the Electronic Supplementary Materials ESM 4*.*

Additional exploratory analyses
We noted that, particularly in the female STEM manager group (n = 50), the sample was quite small, and thus, there may have been power issues (see the detailed power analysis in Appendix C). To increase the power and to also test for another potential moderator, we decided to expand the sample to include employees without management status and to use management status as an additional binary moderator. We ran Models 2, 3, and 4 again with management status.

RESULTS
Table 1 presents descriptive statistics and weighted zero-order correlations[3] for all variables.

Tests of the preregistered hypotheses H1-H4
To test whether traditional gender role attitudes were more pronounced in STEM than non-STEM managers (H1), we ran Model 1. In line with our hypothesis, there was a small, significant, positive relationship between STEM and traditional gender role attitudes when the covariate age was excluded ($\beta = 0.005$, $p < .001$)[4]. However, when we included the covariate age, this tendency was reversed ($\beta = -0.004$, $p < .001$), indicating that traditional gender role attitudes were less pronounced in STEM managers. The multiverse analysis[5] showed that the relationship between STEM and traditional gender role attitudes was negative in only two analyses, positive in 22 out of 24 analyses, and significant in only 8 out of 28 analyses. The effect in the multiple linear regression[6] was very small ($f^2 < 0.001$), and thus, required further investigation. In this analysis, when the covariate age was included, it was significant ($\beta = 0.09$, $p < .001$) with an effect size of $f^2 = 0.006$ in the multiple linear regression. An additional analysis showed

that STEM and traditional gender role attitudes were significantly related (β = -0.05, $p < .001$) in Model 2 when we added the variable gender; however, the direction was contrary to the hypothesis with a small effect of $f^2 = 0.001$ in the multiple linear regression, indicating that traditional gender role attitudes were less pronounced in STEM managers than in non-STEM managers. The multiverse analysis showed that this relationship was significant in 14 out of 28 analyses; therefore, when put together with the small effects, it needed to be considered a preliminary tendency. The covariate age was significant (β = 0.09, $p < .001$) with an effect of $f^2 = 0.005$ in the multiple linear regression, but it did not change the general direction of the model.

Table 1
Weighted means, standard deviations, and zero-order correlations in the total sample including non-managerial employees

Variable	*M*	*SD*	1	2	3	4
1. Attitudes	3.45	1.43				
2. STEM	0.10		-.02*			
3. Gender	0.47		-.15**	-.18**		
4. Age	46.11	12.05	.04**	-.02*	.03**	
5. Manager	0.29		-.01	.04**	-.14**	.02

Note. M and *SD* stand for mean and standard deviation, respectively. For dichotomous variables, *M* indicates the relative frequency. Age (in years) is a continuous variable. Gender role attitudes are ordinally scaled (Likert scale, ranging from 1 to 7, with higher values indicating more traditional attitudes). Dichotomous variables are STEM (non-STEM = 0, STEM = 1), gender (male = 0, female = 1), and management status (non-manager = 0, manager = 1). N = 10,101. *$p < .05$. **$p < .01$.

To investigate the relationship between gender and traditional gender role attitudes (H2), we ran Model 2, in which we added the variable gender to Model 1. As hypothesised, in male managers, traditional gender role attitudes were more pronounced than in female managers (β = -0.24, $p < .001$) with a small to medium effect size of $f^2 = 0.06$ in the multiple linear regression. The multiverse analysis showed that this relationship was significant at the .01 level across the 28 analyses.

To test whether traditional gender role attitudes were less pronounced in male non-STEM managers than in male STEM managers (H3), we ran Model 3. There was a significant relationship between STEM and traditional gender role attitudes (β = -0.03, $p < .001$) in 8 out of 28 analyses; however, it was contrary to the expected direction and indicated that gender role attitudes in STEM were less traditional than in non-STEM fields. The covariate age was significant again (β = 0.13, $p < .001$) with a small effect of $f^2 = 0.01$ in the multiple linear regression.

To investigate whether traditional gender role attitudes differ between women who are managers in STEM compared to other fields, we ran Model 4. Traditional gender role attitudes were less pronounced in female STEM managers than in female non-STEM managers (β = -0.15, $p < .001$) and significant in 24 out of 28 analyses in the multiverse analysis. There was a small effect size of $f^2 = 0.005$ in the multiple linear regression. The covariate age was significant in 4 out of 14 analyses (β = 0.02, $p < .001$) with a very small effect size of $f^2 < .001$ in the multiple linear regression, indicating that age differences were not meaningful.

Exploratory analyses

In the expanded sample, we added the binary variable management status. We again ran Models 2 to 4. Table 2 shows the means of the resulting groups, indicating that women had less traditional gender role attitudes than men and that STEM respondents had less traditional gender role attitudes than non-STEM respondents. The difference between the lowest female group mean of 2.48 and the highest female group mean of 3.34 was 0.86. By contrast, the male means differed by only 0.21, which was only ¼ of the difference in women.

Table 2

Weighted means and standard deviations in traditional gender role attitudes per group

Gender	Management status	STEM vs. non-STEM	*M* attitudes	*SD* attitudes
Female	Manager	STEM	2.48	1.15
Female	Non-manager	STEM	2.68	1.32
Female	Manager	Non-STEM	2.99	1.46
Female	Non-manager	Non-STEM	3.34	1.42
Male	Non-manager	STEM	3.5	1.36
Male	Manager	STEM	3.63	1.37
Male	Non-manager	Non-STEM	3.65	1.37
Male	Manager	Non-STEM	3.71	1.44

Note. Values were sorted from the smallest to largest mean.

We ran a model with STEM vs. non-STEM, gender, and management status as independent variables and age as a covariate. It showed that, in women, traditional gender role attitudes were less pronounced (β = -0.16, $p < .001$ with an effect of $f^2 = 0.03$ in the multiple linear regression; significant in all 28 analyses in the multiverse analysis). In STEM fields, traditional gender role attitudes were less pronounced (β = -0.05, $p < .001$ with a smaller effect of $f^2 = 0.002$ in the multiple linear regression; significant in 24 out of 28 analyses). In managers, traditional gender role attitudes were less pronounced (β = -0.05, $p < .001$ with an effect of $f^2 = 0.001$ in a multiple linear regression; significant in all 28 analyses). The covariate age (β = 0.06, $p < .001$) was significant in 11 out of 14 analyses with an effect of $f^2 = 0.002$ in the multiple linear regression.

When running the same model in the men-only sample, management status was significant in only 7 out of 28 analyses (β = -0.01, $p < .001$); however, in four analyses, being a manager was related to less traditional gender role attitudes, and in 20 analyses, being a manager was related to more traditional gender role attitudes. The effect was very small ($f^2 < 0.001$ in the multiple linear regression), and thus, there was no meaningful discrepancy between male managers and non-managers. The covariate age was significant (β = 0.09, $p < .001$) in all 14 analyses (with an effect of $f^2 = 0.006$ in the multiple linear regression). STEM (β = -0.03, $p < .001$) was significant in all 28 analyses (with an effect of $f^2 = 0.001$ in the multiple linear regression), indicating that traditional gender role attitudes were less pronounced in STEM fields.

When running the analysis in the women-only sample, management status was more strongly linked to traditional gender role attitudes (β = -0.12, $p < .001$) and significant in all 28 analyses, meaning that, in managers, traditional gender role attitudes were less pronounced (with a small effect of $f^2 = 0.01$ in the multiple linear regression). STEM (β = -0.12, $p < .001$) was significant in all 28 analyses (with an effect of $f^2 = 0.008$ in the multiple linear regression). Age was positively related to traditional gender role attitudes in 8 out of the 14 analyses and negatively related in 4 out of the 14 analyses, but the effect was significant in only 4 out of the 14 analyses (β = 0.02, $p < .001$). The effect of age was very small ($f^2 < 0.001$ in the multiple linear regression), and when considered along with the diverging directions, there was no meaningful relationship.

DISCUSSION

The present study used a large sample that was representative of the German population. To explain differences in gender role attitudes, we considered occupational field (STEM vs. non-STEM), gender, age, and management status. In this large sample, we were able to detect even small effects and trends. As we used a multiverse analysis (Steegen et al., 2016), we were able to balance the advantages and disadvantages of different methods. Overall, we found support for the hypothesis that men hold more traditional gender role attitudes than women do. Surprisingly, we found that gender role attitudes were more modern in STEM fields than in non-STEM fields. In addition, we found that for men, age was related to traditional gender role attitudes (the older, the more traditional), whereas for women, no such association was found. For women, being a manager was negatively related to traditional gender role attitudes.

Consistent with our expectations and in line with previous research (e.g., Brewster & Padavic, 2000), traditional gender role attitudes were stronger among male managers than among female managers. The effect was stronger in the management sample than in the sample that included non-managerial employees, too. More traditional gender role attitudes may lead managers in particular to not be supportive of gender equality and diversity in the workplace. Given the undisputed role of support through mentoring and sponsorship not only for women's careers (Helms et al., 2016), such attitudes might have a negative impact not only on female employees, but also on others and the organisation.

Contrary to our hypothesis, gender role attitudes were not more traditional among STEM managers than among non-STEM managers. On the contrary, there was an effect that was significant in most analyses, albeit small, suggesting that

STEM managers had less traditional gender role attitudes than non-STEM managers did. This finding is in contrast to previous research that showed that men who enter STEM occupations adhere to more conventional gender ideologies (Sassler et al., 2017). It is also in contrast to reports of women in STEM who experience more discrimination than women in non-STEM fields (Blackwell et al., 2009). However, the finding is in line with some other studies that showed that men with modern gender role attitudes are more likely than other men to end up in STEM occupations (Dicke et al., 2019) and that, at least in the field of mathematics, there is a shift away from traditional gender role attitudes (Toh & Watt, 2022). We speculate that inconsistent past findings may be due to ongoing societal changes regarding the role of women and gender role attitudes. Various kinds of data on gender role attitudes (Dicke et al., 2019; Sassler et al., 2017) are from the 1980s/90s, and the impacts of the third and fourth waves of feminism (Mohajan, 2022) may show up in later data (Bolzendahl & Myers, 2004). Moreover, the shortage of and increasing demand for employees in STEM (Farndale et al., 2021) may also have contributed to welcoming women into STEM, and positive experiences employees have had in mixed-gender teams may have reduced traditional stereotypes.

We found that older managers in general and men overall had more traditional gender role attitudes than women. The association of age and gender with traditional attitudes was in line with our expectations and previous research (Lynott & McCandless, 2000; Sweeting et al., 2014). By contrast, in women, we found no significant association between age and gender role attitudes, which was unexpected. We speculate that among women more than among men, attitudes may have changed in recent decades on the basis of personal experiences with discrimination.

Moreover, we found that traditional gender role attitudes were less pronounced among female managers in STEM fields than among female managers in non-STEM fields. This finding was in line with our hypothesis, and although we initially attributed this phenomenon to self-selection processes, our findings on less traditional gender role attitudes in STEM suggest an overall trend beyond gender distinctions. We discuss this issue further in the following section.

We expanded the sample to include non-managers and distinguished employees on the basis of whether or not they had management status. We found that traditional gender role attitudes were less pronounced in the female workforce, managers, the STEM workforce, and the younger workforce compared with others. In the male sample, we observed that those who were older and not employed in STEM fields displayed more traditional gender role attitudes. Conversely, when we examined only the women, we found that those who did not hold a managerial position and were not employed in STEM fields displayed more traditional gender role attitudes than others, and there was no significant effect of age. These results suggest that whereas age is a factor in determining traditional gender role attitudes among men, it is management status that plays an important role in determining these attitudes among women—underscoring the idea mentioned earlier that attitudes among men may have changed in recent decades and over generations. Moreover, the effect of working in a STEM field was stronger in the female sample than in the male sample. This finding shows that for women—who are a minority in STEM—working in the male-dominated work environment of STEM is more influential than it is for the majority group of men.

We think that this asymmetry of the effect of working in a STEM field may be due to the following processes. For women, two processes may play a role: First, as argued in the theory section, selection may be relevant, not only for career entry as found in previous research (Dicke et al., 2019), but also for the chance to advance to leadership positions. Women with modern gender role attitudes may be more likely to seek leadership positions in STEM, and thus, break with traditional role models, whereas women with more traditional gender role attitudes may leave STEM fields or abandon their careers before being promoted. Second, experiencing a modern gender role as a female manager—especially in a male-dominated environment—may shape women's attitudes. They may experience being equal in the ability to complete tasks as well as in competence and may thus abandon traditional views. Neither process applies to men, a fact that may explain why men's management status was unrelated to traditional gender role attitudes.

Implications

Given previous findings that suggested that there is more discrimination against women in STEM fields than in other fields, the finding that people who work in STEM fields tend to be more likely than others to have modern attitudes toward gender roles is novel and may indicate that change has occurred. This finding means that non-STEM fields may learn from this development in STEM fields to further reduce traditionalism. In STEM fields, this finding can be used as an additional argument to encourage women to work in STEM jobs—given that many women perceive STEM as a field in which biases and prejudice are extremely prevalent (O'Connell & McKinnon, 2021). Additionally, some women's own traditional attitudes and internalized stereotypes can reduce their motivation to enter STEM fields (Starr, 2018) and may even ultimately prevent them from doing so. More research is needed to show what exactly the barriers are.

Our results show which additional variables should be considered when exploring traditional attitudes about gender: Age, gender, and management status are important factors, too. Although our findings on age and gender individually are not surprising, it is their combination that is most interesting. Older men have rather traditional attitudes regarding gender roles, but older women do not. Women, on the other hand, have less traditional attitudes toward gender roles when they are in a leadership position than when they are not. For women, further clarification is needed to show why this is the case and whether selection or socialisation (or both) are the reason(s) for this fact. With men, one might think that time has changed traditionalism. Although it seems reasonable that the effect is due to a cohort effect, we cannot test this hypothesis with cross-sectional data. For the time being, it is important to diversify boards and decision makers to counterbalance such effects—in both STEM and non-STEM fields.

Limitations and future research

First, the effects we found were small. However, their small size does not mean that they are meaningless. Small effects are worth taking seriously (Funder & Ozer, 2019), and they may be important; for example, the effect of chemotherapy on breast cancer survival is only r = .03 (Meyer et al., 2001), but the effectiveness matters for survivors. In particular, effects that are novel, such as the effect that workers who are not in STEM fields have more traditional attitudes than STEM workers, are worth attending to and investigating further. Even if the effects were small, the robustness of our results was supported by the fact that the sample was large and diverse. Furthermore, a multiverse analysis supported the evidence: The (small) effects were consistently found in various analyses. When this was not the case, we reported the fact transparently, thus supporting the credibility of the results (Steegen et al., 2016).

Second, the SOEP data are panel data and data collection was beyond our control. The data were collected via face-to-face interviews (Goebel et al., 2019). The use of interviews may have led to social desirability effects that could have obscured the size of the effects, as people with strong traditional gender role attitudes may have downplayed the strength of their attitudes. We therefore recommend that data on topics related to stereotypes be collected anonymously in future studies.

Third, we found differences in our analyses, for example, between managers and non-managers and between age groups. However, because we used a cross-sectional analysis, we could not fully disentangle effects of age, period, and cohort. There are longitudinal studies on gender role attitudes and STEM career decisions (Dicke et al., 2019; Sassler et al., 2017), but these studies surveyed gender role attitudes 30 to 40 years ago and focussed on career development in the years that followed. Thus, they cannot provide insights into contemporary associations. There is a need for future research on changes in traditional gender role attitudes and, more broadly, stereotypes in a longitudinal research design with several age cohorts.

Fourth, STEM and non-STEM are broad categories. It may be interesting to further look at different sub-disciplines, as we know that gender differences vary in size depending the sub-discipline of STEM (Su et al., 2009).

CONCLUSION

Our results partially confirmed known associations: Men have more traditional gender role attitudes than women do. In part, our results were surprising: The STEM workforce is more modern than previously thought, and women in management positions are more modern than women who do not hold such a position. This difference could be an effect of selection or socialisation (i.e., exposure to non-traditional attitudes in a non-traditional role). Longitudinal research is necessary for more clarification.

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ENDNOTES

[1] Stereotypes are "qualities perceived to be associated with particular groups or categories of people" (Schneider, 2004, p. 24), e.g., "Women are bad in math." An attitude is "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1), e.g., a tendency to evaluate the role description "It is best for the husband and wife to work equally so that they can share family and household responsibilities equally" either favourably or not. Even though gender stereotypes and gender role attitudes are two different constructs, they are correlated (Eagly & Madlinic, 1989).

[2] In this case and often in Germany in general, numbers for "MINT" instead of STEM are reported. MINT stands for Mathematik, Informatik, Naturwissenschaften, Technik—meaning mathematics, computer science, natural sciences, technology. Even though the terms are often similarly used, the definitions vary slightly.

[3] We report Pearson correlations, means, and standard deviations, knowing that ordinal data require different methods. As means are more insightful than medians, we report means and their corresponding standard deviations. We additionally calculated Kendall's tau, and the results were almost identical to the results for the Pearson correlations. We report Pearson correlations because they are more common.

[4] In the following, unless we indicate differently, we report standardised, weighted results that include age as a covariate.

[5] Our multiverse analysis consisted of all standardised versus unstandardised results, weighted versus unweighted, including and excluding the covariate age, and all four models (ordered probit regression based on the median, based on the mean, multiple linear regression, and ANOVA). ANOVA was only run with unstandardised values, resulting in 2*2*2*4-4 = 28 analyses. For 24 analyses, we could report positive or negative directions; directions could not be provided for the ANOVA. As we ran every analysis once with and once without the covariate, we had 14 analyses including the covariate age (for 12, we could report positive or negative directions).

[6] Ordered probit regression does not allow any effect sizes to be computed. Thus, effect sizes from the multiple linear regression (partial f^2) are reported in the text. Additionally, we computed the effect size for ANOVA (η^2), which is reported as part of our multiverse analysis tables (see the Electronic Supplementary Materials ESM 4).

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APPENDIX

Appendix A

Overview of variables, items, and response format in the SOEP data sets

Dataset	Item	Variable	Item wording	Response format
Core 2018	bip_53	Job change	**Have you changed jobs or started a new one since December 31, 2016?** This includes starting working again after a break!	Yes/No
Core 2017	bhp_63	Supervisory position	**In your position at work, do you supervise others?** **In other words, do people work under your direction?**	Yes/No
Core 2017	bhp_64	Number of people directed	**How many people work under your direction?**	Total number
Core 2018	bip_197	Gender role attitudes	**I will read you a series of statements.** **To what degree do you personally agree with each statement?** Please answer according to the following scale: 1 means disagree completely, and 7 means agree completely. a) Children below the age of 6 suffer if their mother works b) Children below the age of 3 suffer if their mother works c) It’s best if the man and the woman work the same amount so they can share the responsibility for taking care of the family and household equally. *Note.* The question had included five statements that are not used in the present study, because they do not focus on gender	7-point Likert scale

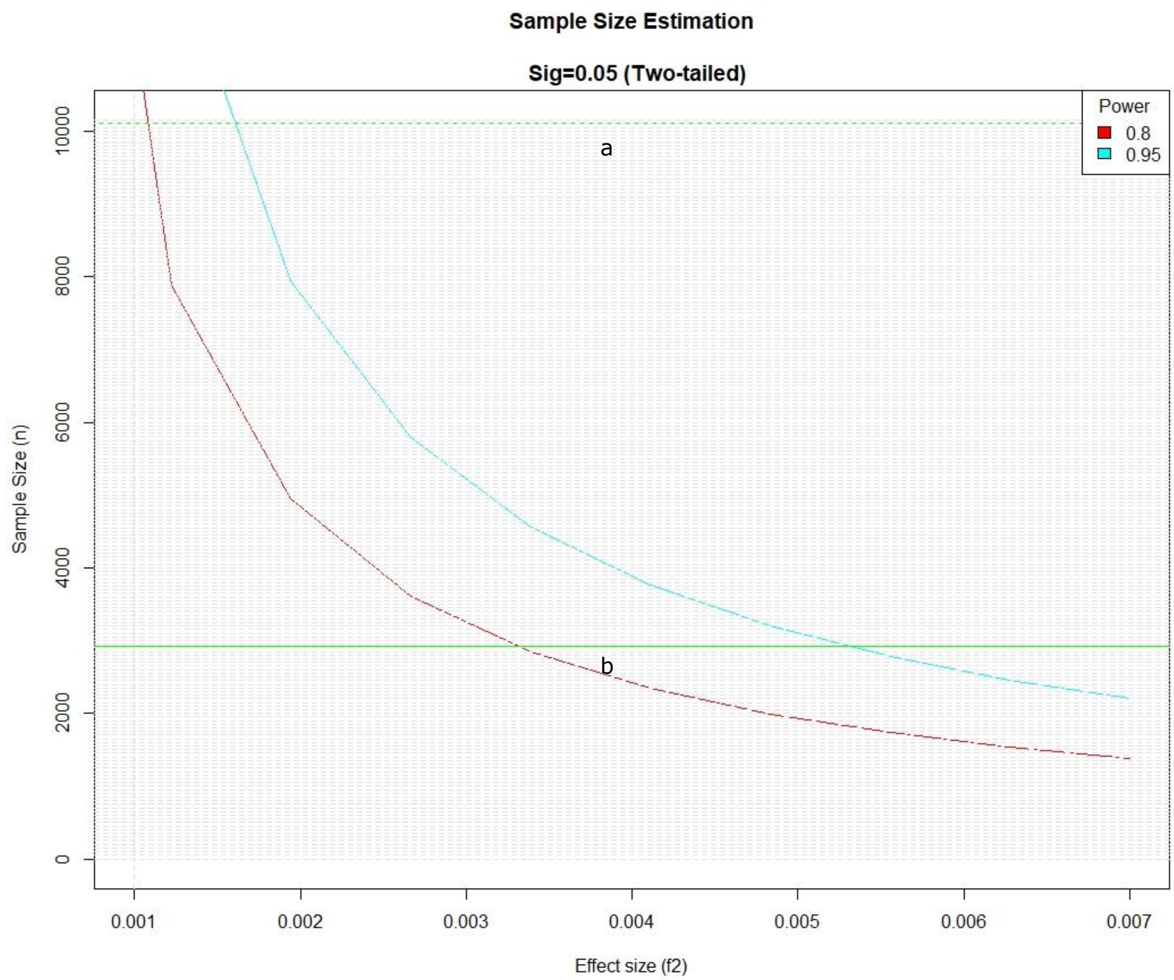
			but on other traditional attitudes, e.g., "A person who is living with their partner for a long time should get married".	
Core 2018	bipbirthy	Age	**Year of birth of respondent**	4-digit year
Core 2018	bipbirthm	Age	**Month of birth of respondent**	1 to 12
Core 2018	bipmonin	Age	**Month of interview**	1 to 12
Core 2018	biptagin	Age	**Day of interview**	1 to 31
Core 2018	sex	Gender	**Sex of respondent** *Note.* Sex of respondent was assessed dichotomously in the SOEP.	Male (0), Female (1)
Core 2018	pgisco08	ISCO-08 Job code	**Current occupation**	Code

Appendix B

Overview of sample

Gender	Management status	STEM vs. non-STEM	Group size (*N*)	Percentage of total sample
Male	Non-manager	Non-STEM	2,616	25.9%
Male	Non-manager	STEM	467	4.6%
Male	Manager	Non-STEM	1,517	15.0%
Male	Manager	STEM	309	3.1%
Female	Non-manager	Non-STEM	3,924	38.8%
Female	Non-manager	STEM	177	1.8%
Female	Manager	Non-STEM	1,041	10.3%
Female	Manager	STEM	50	0.5%
Total	Total	Total	10,101	100%

Appendix C
Power analysis



Note. This figure shows power (red and blue lines) relative to the effect size and sample size. The green lines indicate the sample. [a] The line indicates the full sample of *N* = 10,101, including non-managers. [b] The line indicates the manager-only sample of *N* = 2,917.