Gender differences in economic preferences and gender equality are yet unrelated: a replication of Falk and Hermle (*Science*, 2018)

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Abstract

This study replicates and extends the key components of the analysis of Falk and Hermle published in Science (2018), where the gender differences in economic preferences (time preference, altruism, willingness to take risk, negative and positive reciprocity, and trust) were related to economic development and gender equality of the countries. During the replication, we identified and investigated some potential issues in the original analysis methodology, particularly with the construction of the joint Gender Equality Index as a measure of gender equality in a country. Besides, we revealed a strong and statistically significant association between economic development and several gender equality indexes, which signifies that only a conditional regression with control on economic development may uncover the separate role of gender equality on gender differences. We conducted a further analysis using as gender equality index the Global Gender Gap Index from the WEF, the Gender Inequality Index and the Gender Development Index from the UNDP. When analysing the data using these indicators, we confirmed the strong and statistically significant association of gender differences with economic development conditioned on gender equality, as found in the original analysis, but only a weak correlation between gender differences in economic preferences with gender equality, when conditioning on economic development, was found. A more detailed investigation of single preferences further confirmed this conclusion, demonstrating mild and statistically significant association for only two preferences out of 18 preference-gender equality index combinations. Our findings suggest the absence of evidence of an association between economic preferences and gender equality given the data available, current methodology, and existing indexes for measuring gender equality.

JEL: C18 - Methodological Issues: General, D010 - Microeconomic Behavior: Underlying Principles, D630 - Equity, Justice, Inequality, and Other Normative Criteria and Measurement, D810 - Criteria for Decision-Making under Risk and Uncertainty, D910 - Micro-Based Behavioral Economics: Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making, F000 International Economics: General

Keywords: replication study, gender differences, economic preferences

Data availability: The code used for this analysis (replication and extended) can be found on GitHub at https://github.com/scerioli/Global-Preferences-Survey

1. Introduction

Gender differences in economic behaviors, such as happiness (Schneider *et al.* 2012), competition (Croson & Gneezy 2009; Gneezy *et al.* 2009; Klonner *et al.* 2021), or work preferences (Beblo & Görges 2018), have been studied in sociology, psychology, and economics for many decades. Published findings on this topic and their relation to gender inequality are frequently used to influence decision and policy-making, both in the public and privat sector. In turn, gender inequality topics are becoming a more integral part of the agenda for many public and private institutions and organizations, and it is essential for the stakeholders to reveal, estimate, monitor, and prevent gender inequalities on the individual, group, and country levels.

The study of gender differences on a world scale is challenging. One challenge that hampers the progress is the lack of large and homogeneous datasets across different social groups and countries. The Gallup World Poll 2012 included a Global Preference Survey conducted on almost 80000 people in 76 countries around the world that aimed to fill this gap, covering nearly 90% of the world population representation, with each country having around 1000 participants answering questions related to their time preference (patience), altruism, willingness to take risk, negative and positive reciprocity, and trust. The dataset provides a unique insight into the economic preferences of a heterogeneous groups of people.

An article that presented an analysis of this dataset was published in the Quarterly Journal of Economics (Falk *et al.* 2018). It focused on general questions about the economic preferences distributions in different countries, exploring several covariates from the Gallup World Poll. The subsequent article (Falk & Hermle 2018a), replicated in this work, focused explicitly on the gender differences highlighted in the previous study and reported evidence for the relationships among gender differences in economic preferences, economic development, and gender equality across many countries. The authors propose two competing hypotheses to be tested. The first one is that the gender differences in economic preferences will decrease for more economically developed and gender-equal countries, because social roles related to gender are attenuated. The second hypothesis is to the contrary, that for more economically developed and gender-equal countries, the gender differences in economic preferences will increase because the gender-neutral goal of subsistence is removed and thus people can pursue their more unconstrained set of preferences. Their analysis shows a positive correlation between gender differences in preferences and economic development (expressed as log GDP p/c), as well as a positive correlation between gender differences in preferences and gender equality of the countries. Therefore, the authors conclusion favors the second hypothesis, predicting an increase in the differences as women and men obtain sufficient access to the resources to develop and express their intrinsic preferences independently.

However, an essential relation between the economic development and gender equality indexes was only mentioned in the original text without detailed investigation. At the same time, this relation plays a pivotal role in interpreting the resulting correlations. As an additional point of critique, the authors composed a joint measure of gender equality in different countries using two officially recognized indexes to measure gender equality (WEF Global Gender Gap and UNDP Gender Inequality Index), together with two other less complete indicators, providing a little discussion about the validity and robustness of these supplementary indicators, and without establishing a link to the existing literature with this regard. The present work aims to provide a companion set of conclusions based only on the validated indicators. We wish to raise awareness about the potential ramifications of drawing the wrong conclusion about the relationship between gender differences in economic preferences and gender equality when crafting public, corporate, or NGO policy.

In this study, first, we conduct a pure replication of the reviewed analysis using the R programming language to extract gender differences in economic preferences from the available datasets. Second, we analyse the relationship between economic development and gender equality, as well as the joint gender equality index used by the original authors, highlighting the importance of using established indexes with conditional analysis. Finally, we demonstrate that findings on the relationship between gender differences and economic development lack evidence and do not hold when the conditional analysis is carried out with established gender equality indexes.

2. Results

Gender differences in economic preferences: replication of the original analysis

In this section, we briefly describe the methodology of the original article and provide information on the replication to obtain gender differences in economic preferences and match our analysis with the results of the original article. We refer to this as a pure replication.

To conduct the replication, we requested the Gallup World Poll data. The full dataset is under restricted access, and education level and household income quintile on the individual level of the participants are not available in the open-access version (for more information, see Appendix, Section 2, "Data Collection, Cleaning, and Standardization"). Anyway, in Falk & Hermle (2018b) the authors provide a control analysis, where all the independent variables were dropped but the gender, and the results were still robustly pointing to the same direction as they found using all the variables available. Therefore, we decided to continue the reproduction without having access to education level and the income quintile.

To assess the gender differences in each economic preference, the following model was used:

$$\mathrm{p}_i = \beta_1^c \mathrm{female}_i + \beta_2^c \mathrm{age}_i + \beta_3^c \mathrm{age}_i^2 + \beta_4^c \mathrm{subjectiveMathSkills}_i + \epsilon_i$$

where the subscript i is the index of a survey participant. This results in 6 models – one for each preference measure, p_i – having an intercept and 4 coefficients, each coefficient being related to the variable in the formula above. The coefficient for the dummy variable *female*, β_1^c, is used as a measure of the country-level gender difference. Therefore, in total, there are 6 coefficients representing the preference differences related to the gender for 76 countries. To summarise the gender differences among the six economic preferences, a principal component analysis (PCA) is performed on the gender coefficients. The PCA is a dimensionality-reduction technique which allows a reshaping of the 6 coefficients into orthogonal components that maximize the sample variance. The first component of the PCA has then been used as a summary index of average gender differences in preferences.

We managed to replicate the analysis and obtain the gender differences in the economic preferences at the country level (for details, see Table 1 in the Appendix). A diagnostic test of the linear regressions indicated the presence of non-normality. We ran an analysis based on robust linear regression instead of ordinary linear regression to mitigate potential downstream biases. The results in the following tables are denoted as "replication" when the method of the linear regression was OLS as in the original paper, and "extended" when the robust linear regression was instead performed.

Relation between gender differences, economic development, and gender equality

To study the effect of both GDP p/c and gender equality, at the same time, one should incorporate all three variables into a multiple linear regression model with both factors as explanatory variables, for example:

$$\mathrm{avgGenderDiff}_{\mathrm{country}} = \alpha + \beta_1 \ \mathrm{logGDPpc}_{\mathrm{country}} + \beta_2 \ \mathrm{genderEquality}_{\mathrm{country}}$$

Alternatively, to separate the contributions of economic development and gender equality, one can perform a regression conditioning on the gender quality indicator first and then conditioning on economic development. The theorem from Frisch–Waugh–Lovell (Frisch & Waugh 1933; Lovell 1963) guarantees that the coefficients found from this conditional analysis are the same as those found for a regression of the gender differences on both economic development and gender equality index of the countries.

The correlation between economic development and gender equality indexes plays a central role in investigating how the gender differences in economic preferences are related to them. The fact that the two variables are not independent is well known and subject to previous studies (Duflo 2012; World Economic Forum 2015). To check the correlation between economic development and gender equality of the countries analysed in the study, we regressed the Log GDP p/c and joint Gender Equality Index used by the authors in the original article. In addition, we explored the correlation of other three indexes for the measure of gender equality: two were indexes already introduced by the original authors, that are the Global Gender Gap Index from the World Economic Forum Global Gender Gap Report 2015 (abbreviated to WEF GGGI), and the Gender Inequality Index from the United Nations Human Development Report 2015 (UNDP GII). The third index to be used for the correlation check was the UNDP Gender Development Index (GDI), which we will later use for the extended analysis. The correlation between economic development expressed in Log GDP p/c and gender equality indexes in the countries is very strong (see also Figure 1): for the Gender Equality Index, we found a correlation with $r = 0.5440$ and a p-value < 0.0001; for WEF GGGI, $r = 0.2926$ and p-value $= 0.013$; for UNDP GII, $r = 0.8542$ and p-value < 0.0001; and for the UNDP GDI, a correlation of $r = 0.5316$ with p-value < 0.0001.

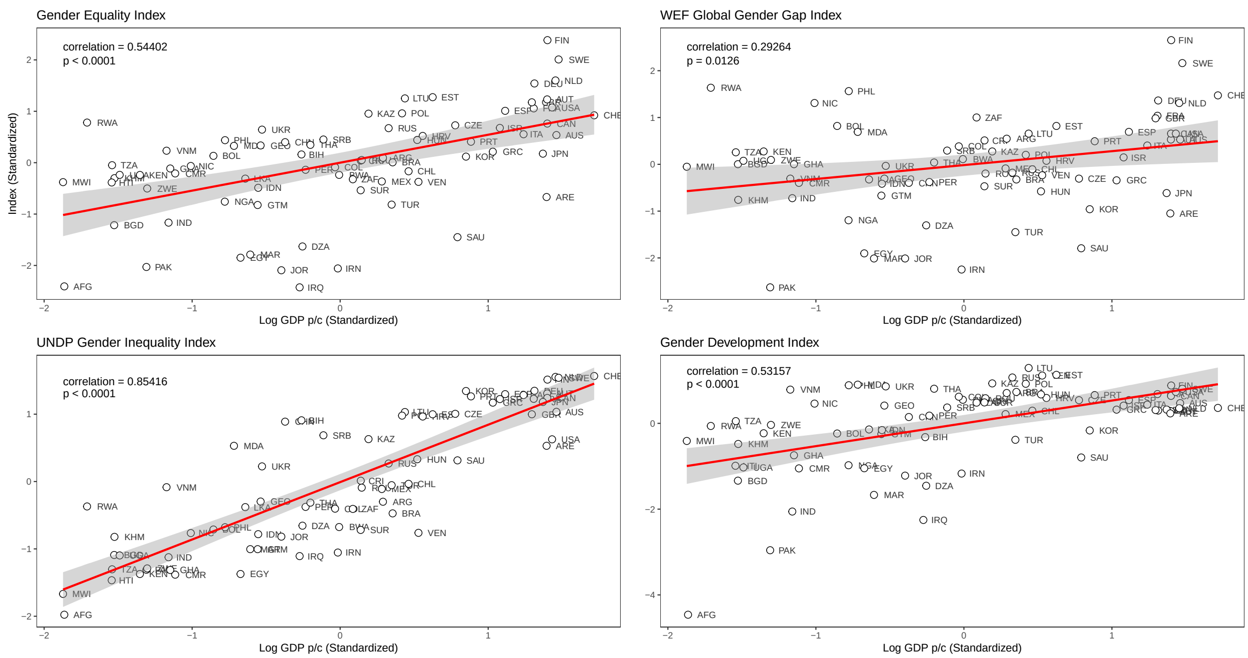

Figure 1: Correlation between gender equality indicators and economic development by country. Note that only the countries participating in the original study are included.

Gender equality indexes and potential issues

As already anticipated, the authors in the original article composed a joint measure of gender equality that denoted as Gender Equality Index (GEI). To charactarize its structure, we visualized its composition with the diagram shown in Figure 2. The authors built this joint measure by using the PCA technique on four gender-equality indicators, and taking the first component as a summary index of gender equality. Two of these indicators are indexes officially approved by international organizations, the WEF GGGI, and the UNDP GII; one is a widely used trusted quantity, the ratio of female and male labor force participation, taken from the World Bank database; and lastly, an indicator newly constructed by the authors the time since women suffrage, with the data taken from the Inter-Parliamentary Union website, presumably to track long-term influences of the guaranteed right to vote as a proxy of gender equality. The WEF GGGI has a total of fourteen sub-indexes, grouped and weighted into four categories: economic participation and opportunity, political empowerment, educational attainment, and health and survival. The UNDP GII follows a similar logic to cover the same categories describing different aspects of the human life, but using only five sub-indexes in total: two for health and reproduction-related issues, and three others for the remaining categories.

The UNDP GII has been criticized by several authors (Anand & Sen 1995; Permanyer 2013; Klasen 2017). This index is said to be highly related to economic development, as it includes reproductive health indicators that can penalize less-developed countries, and it has an nonexistent measure of the welfare loss associated inequality, because it is based on a calculated gender equality measure not apparetly documented publically. One of the coefficients that has a highest priority (~30% of the sub-index) in the calculation of the measure of the economic participation and opportunity, called "wage equality between men and women for similar work" – indicating how much women receive with respect to men for the same work – is based on a best experts' guess, not corrected on the difference in occupation (Halkos *et al.* 2021). Instead, the power and limitation of WEF GGGI index remains mostly undiscussed in the academic literature, with a few exceptions (Barns & Preston 2010; Piper 2019). The index is thought to be the least dependent on the economic development of a country, since it measures the gap between male and female access to resources and opportunities (World Economic Forum 2006). Still, as the result of the previous section suggests, this dependence exists and it is not negligible. Despite the identified limitations, these indexes remain the most homogeneous and standardised

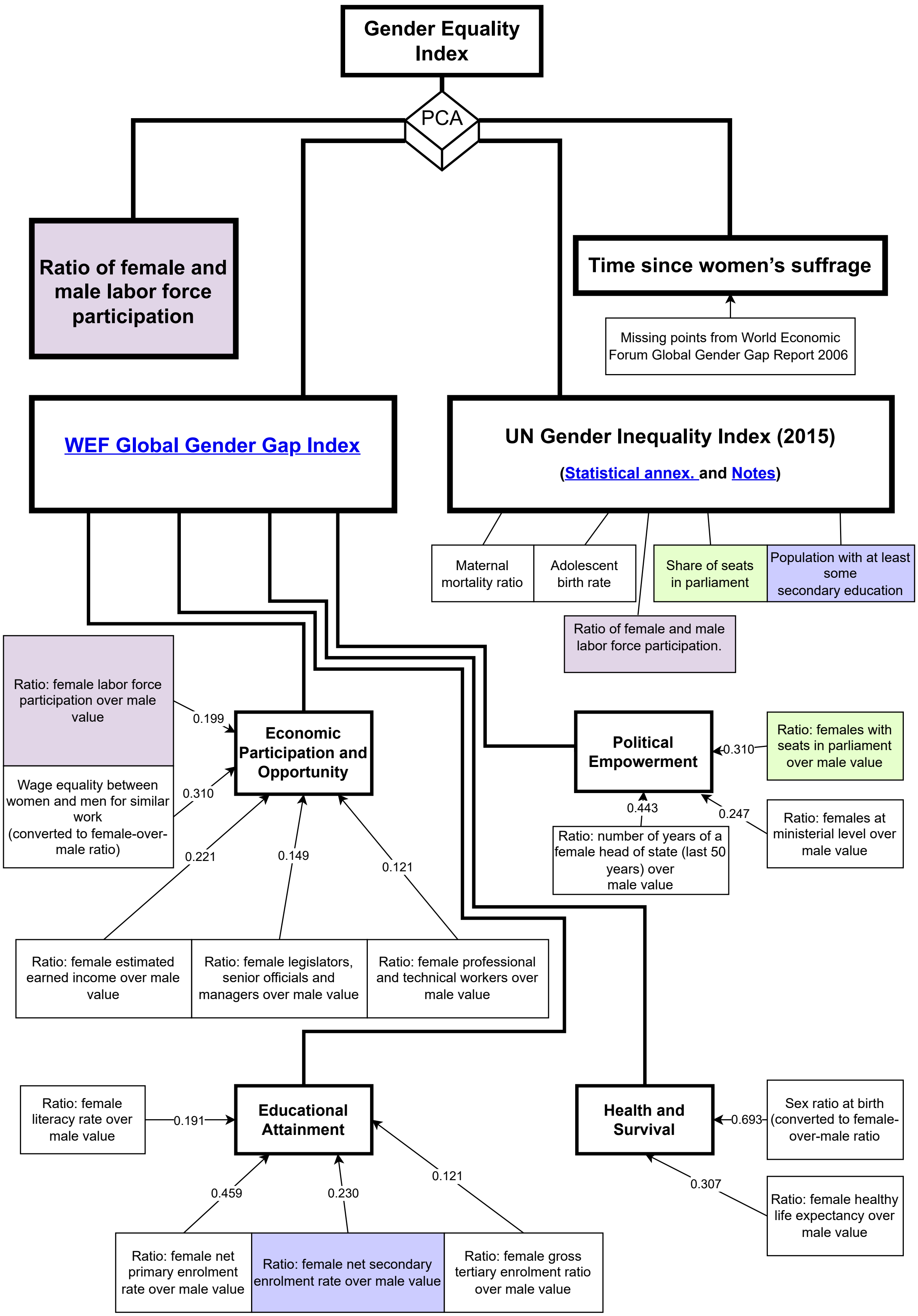

Figure 2: Gender Equality Index decomposed in its sub-indexes.

estimates of gender inequality on the world scale.

Along with WEF GGGI and UNDP GII, other indexes exist, such as the GDI already introduced in the previous section, that was discussed first in Klasen (2017) and recently introduced in the UNDP report. It captures three dimensions in terms of health, knowledge, and living standards, separately for male and female. This index is defined as the ratio of the Human Development Index for female divided by that for male. The life expectancy, expected and mean years of schooling, and GNI per capita are calculated within these dimensions. We include this index in the further analysis.

The justification for using GEI built from the PCA rather than the widely used indexes such as WEF GGGI and UNDP GII was largely omitted in the original article. As one can see in Figure 2, the components of the GEI used in the original study contain repetitions. The two indexes WEF GGGI and UNDP GII share three sub-indexes, here indicated with different colors: ratio of female and male labor force participation (purple), the share of seats in parliament (green), and enrollment into secondary education (blue). As a third variable to construct the GEI, the authors used the ratio of female and male labor force participation, already included in the previous two indexes. While the PCA technique in some cases permits the aggregation of the indexes even in the presence of large correlations among the inputs, in the present case, such a procedure leads to an imbalance in favor of these specific repetitive indexes (especially female and male labor force participation) over other factors, which were already balanced in the design of WEF GGGI and UNDP GII indexes.

Furthermore, the *time since women suffrage* index was introduced by the authors to track the long-lasting effects of the right to vote. This is based on the assumption that during the course of the time development has always had a monotonic effect and its magnitude is proportional to the time since women suffrage was established. The data on the year suffrage is available on a global scale, but provides a very limited overview of gender disparities in politics (Carmichael *et al.* 2014). Indeed it can be argued that even after the right to vote was granted, many discriminating laws were still present, and the alignment of law together with the executive branch of the government and elimination of discrimination takes more time – for example, despite gaining the right to vote, the right to work can be suppressed for several decades. This assumption that suffrage played a long-lasting effect on the balance in gender equality sounds reasonable but requires further investigation to be used as a robust estimator. It is also worth mentioning the topic of suffrage and race, which for many countries is strongly intertwined (Carruthers & Wanamaker 2015; Yang 2020).

Based on the issues reside above, we proceed to use GEI to match the replication with the original analysis, and we carry out a complemetary analysis where only the established indicators WEF GGGI, UNDP GII and GDI, in their relationship to the gender differences in economic preferences and the economic development.

Conditional analysis of gender difference and their relationship to economic development and gender equality

In this section, we explore the correlation between the summarized gender differences and the economic deveolopment and gender equality indicators WEF GGGI, UNDP GII, and GDI using a conditional analysis. As can be seen in Figure 3, the gender differences have a strong and statistically significant correlation with economic development when the conditional analysis is performed on the single gender equality indicators, indicating that the economic development of a country seems to play a key role in the measured gender differences in the economic preferences. On the contrary, the correlation between the gender differences and the gender equality indexes of the country, conditioned on the economic development, is only statistically significant for WEF GGGI conditioned on log GDP p/c (p-value = 0.0241), while for UNDP GII and GDI the correlation is not statistically significant.

To investigate the role of economic development and gender equality on single preferences, we performed the same analysis without aggregating preferences into a single measure. As one can see in Table 1, alongside the results of aggregated gender differences, economic development still has in most cases a strong and statistically significant correlation with the single preferences when conditioned on the gender equality of the country.

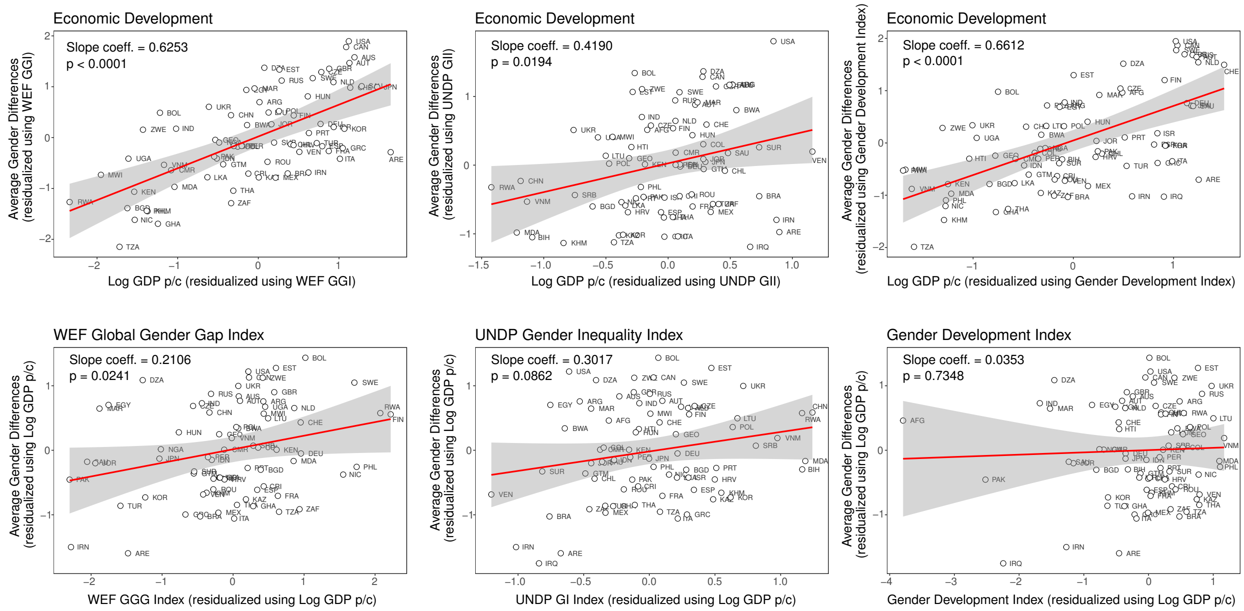

Figure 3: In the top row, gender differences are regressed on economic development conditioned on gender equality for the different indicators (WEF GGGI, UNDP GGI, and GDI). In the bottom row, the corresponding values of gender differences are regressed on gender equality indicator conditioned on economic development.

Table 1: **Gender differences in each economic preference related to log GDP p/c conditional on the gender equality indicators**. The robust linear regression method is used. The correlation terms and their significance levels ≤ 0.001 (***), ≤ 0.01 (**), ≤ 0.05 (*) are reported.

Variable	log GDP p/c	log GDP p/c	log GDP p/c
Conditional on	WEF GGGI	UNDP GII	UNDP GDI
—	—	—	—
Trust	0.5174***	0.1930	0.5045***
Altruism	0.5255***	0.3527***	0.4477***
Positive Reciprocity	0.2898*	0.2054	0.1870
Negative Reciprocity	0.3974**	0.0706	0.3858***
Risk Taking	0.3469**	0.0262	0.3199**
Patience	0.3742**	0.1046	0.3337**

Table 2 summarises the results of the regression of the gender differences in single economic preferences with relation to gender equality indexes conditioned on economic development. In 16 out of 180 regressor-regresee pairs, no statistically significant correlations were observed between the gender equality indexes and any of the single preferences. In two cases cases, weak but statistically significant correlations were found, between the pairs: WEF GGGI-Altruism pair and the UNDP GII-Risk Taking pair. We conclude there is a lack a reliable association between the gender differences in economic preferences and gender equality indexes.

Table 2: **Gender differences in each economic preference related to gender equality indicators, conditional on log GDP p/c**. The robust linear regression method is used. The correlation terms and their significance levels ≤ 0.001 (***), ≤ 0.01 (**), ≤ 0.05 (*) are reported.

Variable	WEF GGGI	UNDP GII	UNDP GDI
Conditional on	log GDP p/c	log GDP p/c	log GDP p/c
—	—	—	—
Trust	0.1325	0.2160	0.0794
Altruism	0.3561**	-0.0421	0.1021
Positive Reciprocity	0.0396	-0.0402	0.1978
Negative Reciprocity	0.1680	0.1742	-0.1033
Risk Taking	0.0349	0.2192*	-0.0261
Patience	0.2312	0.1705	0.0812

3. Discussion and conclusions

In the present article, we replicated the results of the work by Falk & Hermle (2018a) that related gender differences in economic preferences to economic development and gender equality. The analysis and main findings of the original article can be summarised as follows. The authors used the Gallup World Poll 2012 Global Preference Survey to measure the gender differences in economic preferences across 76 countries. They established a joint index that summarises the differences in all six preferences at the same time. They used log GDP p/c as a proxy of economic development, while as a measure of gender equality, several indexes were introduced, including a newly composed joint measure for gender equality (Gender Equality Index, reported as GEI). The authors reported a large and statistically significant association between gender differences and log GDP p/c ($r = 0.67$, p-value < 0.0001) and the GEI ($r = 0.56$, p-value < 0.0001), reflected in the *Research article summary* and graphical abstract. The authors also conducted a conditional analysis to isolate the impact of economic development and the GEI. The association was found to be of a slightly smaller magnitude but still rather strong and statistically significant ($r = 0.53$, p-value < 0.0001) when gender differences were related to log GDP p/c conditioned on the GEI, and moderate and statistically significant ($r = 0.32$, p-value $= 0.003$) when relating with the GEI and conditioning on log GDP p/c. The authors concluded that the evidence indicates that higher levels of economic development and gender equality favor the manifestation of gender differences in preferences across countries, *highlighting the critical role of availability of material and social resources, as well as gender-equal access to these resources, in facilitating the independent formation and expression of gender-specific preferences* (Falk & Hermle 2018a).

Given the importance of these findings and their impact and the impressive size and complexity of the analysis, it is of high value to conduct a detailed reconstruction of the methodology, checking the robustness of assumptions and inferences. As a first milestone, we performed a nearly pure replication, obtaining the gender differences in economic preferences from the Gallup World Poll 2012 Global Preference Survey, using the same methodology as in the original article. Unfortunately, the dataset is publicly available only in preprocessed form and is partially restricted. To some extent, this hampered the replication's comparison with the original findings. Nevertheless, the extracted gender differences were close to the ones from the original article. In addition, we ran the same analysis using robust regression instead of ordinary linear regression as the data revealed signs of non-normality and outliers, but no significant changes in the distribution of gender differences in economic preferences were observed.

We further investigated the indexes used to estimate economic development and gender equality and their relation. First, we observed a strong association between log GDP p/c and the Gender Equality Index built by the authors ($r = 0.5440$, p-value < 0.0001), and other indexes approved by international organizations such as WEF Global Gender Gap Index, UNDP Gender Inequality Index and UNDP Gender Development

Index ($r = 0.2926$, p-value $= 0.013$; $r = 0.8542$, p-value < 0.0001; $r = 0.5316$, p-value < 0.0001, respectively). In the light of this strong correlation, only a conditional regression with control on log GDP p/c may uncover the separate role of gender equality on gender differences. Our conditional analysis indicated a lack of any significant association between gender differences in economic preferences and gender equality measures.

Then, we analyzed the Gender Equality Index built by the authors and investigated its single components. Some methodological issues were identified, and a justification for its usage of more established, balanced measures remains an open question. The GEI is composed of four other indicators: two are widely used indicators coming from the WEF and the UNDP (the WEF Global Gender Gap Index and the UNDP Gender Inequality Index), which in turn are built from 14 and 5 sub-indicators, respectively; one is the ratio of female-to-male labor force participation; and lastly, a newly constructed type of indicator based on years since women were granted suffrage in a country. Our study of previous literature indicates, and as we illustrate in our diagrammatic analysis, both WEF GGGI and UNDP GII indicators already contain the ratio of female-to-male labor force participation and have common sub-indicators related to the share seats in parliament and secondary education. The reason for the additional use of the female-to-male labor force participation as a third component for the GEI remains unclear, as this choise prioritizes this factor over all other factors included in indexes which we caution may lead to an unbalance. At best, the used to determine the gender equality summary index will simply ignore the repeated information, but the potential benefit is not clear. In addition, the index constructed by the authors by standardization of the years since women's suffrage, while an interesting quantity with plausible explanatory power, lacks a basis in the literature as an indicator of gender equality and it remains to be validated as a robust indicator. Based on these findings and the absence of clear procedures in the original article, we find no evidence that the GEI built with PCA performs better (or not worse) than officially sanctioned existing indexes. We caution that the use of novel, not-validated indicators such as the GEI in gender equality studies leads to difficulty in comparing the results of such studies with other research in the domain conducted on global and local scales. To complement the original, we provide a similar analysis based on the widely accepted measures of gender equality.

The gender equality indexes used in our complemetary analysis (WEF Global Gender Gap Index, UNDP Gender Inequality Index, and UNDP Gender Development Index) have themselves certain limitations that were discussed by several authors, and are far from providing a complete representation of gender inequality (Anand & Sen 1995; Barns & Preston 2010; Permanyer 2013; Klasen 2017; Piper 2019; Klonner *et al.* 2021). Despite critics, these indexes are likely the best estimates for the state of gender equality on a global scale. We examined gender differences and their relationship to economic development and gender equality using these indexes on the based of the conditional analysis. We found a large and statistically significant association between gender equality preferences and economic development conditioning on WEF GGGI and UNDP GDI ($r = 0.6253$, p-value < 0.0001, and $r = 0.6612$, p-value < 0.0001, respectively), while for UNDP GII the association was somewhat milder with a larger p-value ($r = 0.4190$, p-value $= 0.0194$), still statistically significant at the 5% confidence level. On the other hand, when conditioning on economic development, no correlation between UNDP GII or GDI and the summarised gender differences was found. Only for the WEF GGGI was the correlation found to be statistically significant (p-value $= 0.024$); however, the r-value was somewhat weak ($r = 0.21$).

We further analyzed how single-gender differences in economic preferences are related to economic development and gender equality. Along with the results for combined gender differences, large and statistically significant associations were demonstrated when we tested the association between gender differences with log GDP p/c conditioning on WEF and GDI. Interestingly, no preferences except *altruism* demonstrated any relation with log GDP p/c when conditioning on UNDP. Furthermore, among six economic preferences and three gender equality indexes, no statistically significant association between economic preferences and log GDP conditioning on the gender equality index was found, except for *altruism* ($r = 0.3561$; p-value $= 0.006$) conditioning on WEF and *risk-taking* ($r = 0.2192$; p-value $= 0.045$) when conditioning on UNDP, demonstrating an absence of support for the presence of a link between single-gender differences in economic preferences and gender equality.

To sum up, gender equality indexes and economic development expressed in log GDP are strongly correlated variables; thus, the association between gender differences in economic preferences and gender equality indexes should be determined by conditioning on economic development. Our conditional analysis suggests that only a mild and sparse association between gender differences in economic preference and gender equality exists (only one preference over six), and the magnitude of the correlation coefficient is at-least two-fold smaller than the association of gender differences and the economic development conditioning on gender equality indexes. Given the results of the reproduced analysis, we conclude that the evidence is not sufficient to support an association between economic preferences and gender equality.

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