

Reproduce the results of the article “Relationship of gender differences in preferences to economic development and gender equality”

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Abstract

This study attempts to reproduce the results of the article of Falk & Hermle (2018a) measuring the gender differences economic preferences relating them to economic development and to gender equality of the countries. In the original paper, the authors use data from the Gallup World Poll 2012, which included a Global Preference Survey conducted on almost 80000 people in 76 countries all around the world. The dataset covers almost 90% of the world population representation, with each country having around 1000 participants answering questions related to their time preference (patience), altruism, will of risk taking, negative and positive reciprocity, and trust. The dataset is available in its integrity only with a license to be paid. The free version has only partial data that can also be used for this purpose because, according to the FH study, the gender differences can be studied also only taking in consideration a smaller number of predictors (according to the supplementary material, see (Falk & Hermle 2018b)). In this replication study, therefore, we use only a subset of predictors that are made publicly available to check whether the results can still be reproduced and are consistent. The outcome of the replication is that we see similar results as the ones obtained by the original authors for the relationship of gender differences and the economic development, but with differences (some times minor, some times significantly large) regarding the gender equality, especially when comparing the results of the single indexes building the general Gender Equality Index. Those differences seem to arise from different handling of the country-level variables, but a further check couldn't be done because the data used in the original article are not provided to us.

JEL: D01 - Microeconomic Behavior: Underlying Principles, D03 - Behavioral Microeconomics: Underlying Principles, F00 - General

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Andrey: was the H is testing hypotheses suggested by the data? The correlation was likely found in previous study on economical preferences and the H was build post hoc. But we need to check if methodologic suggestion existed before in the field. “Publication bias”

1. Introduction

Gender differences are nowadays extensively used as arguments and counter-arguments for decision and policy making, and the differences concerning the economic behaviors, such as happiness (Schneider *et al.* 2012), competition (Croson & Gneezy 2009; Gneezy *et al.* 2009), or work preferences (Beblo & Gorges 2018), are being studied in many sectors of the economy and economy-related fields.

One of the problems common for many experiments in social sciences is the lack of large and heterogeneous datasets that can be used to check for such differences reducing some of the bias induced, for example, by having students or specific sets of people interviewed for the study.

The Gallup World Poll 2012 included a Global Preference Survey conducted on almost 80000 people in 76 countries all around the world, that aimed to fill this gap: Covering almost 90% of the world population representation, with each country having around 1000 participants answering questions related to their time preference (patience), altruism, will of risk taking, negative and positive reciprocity, and trust.

The dataset provides a unique insight in the economic preferences of a heterogeneous amount of people. The original study published in the Quarterly Journal of Economics (Falk *et al.* 2018 p. 133 (4) pp. 1645-1692) focused on more general questions about the economic preferences distributions in different countries, trying to explore different covariates from the Gallup World Poll. While, the subsequent article, replicated in this work, focused specifically on the gender differences arising from the previous study.

The main question that the article wants to study is whether the gender differences in economic preferences increase or decrease as the economic development and gender equality of the countries increase. In the first scenario, the gender differences increase as the economic development increases because the gender-neutral goal of subsistence is removed, and therefore the real preferences can be pursued. Moreover, since those countries are usually also the ones with more gender equal societies, we would have more women and men allowed to express their desires and preferences in an independent way. This would be the so-called resources hypothesis. On the other hand, there is the social role hypothesis stating that the more economically developed and gender-equal the country, the smaller the gender differences because of the attenuation of the social roles related to the genders. The conclusion of the article is that the trends in the data shows a positive correlation of gender differences with GDP p/c and with the gender equality of the countries, and thus “confirming” the resources hypothesis.

The motivation for the replication study came from the wish to apply different analysis beyond the OLS, as for instance multilevel cumulative link models [*cit. link*]. In order to achieve that, one needs first to replicate the original analysis. The replication allowed us to question the data sources and the methods used for data cleaning, and even if the data is not complete, we think it is still interesting to replicate such studies to validate the procedures for the sake of good science.

2. Methods

Overview

We replicate the results using the R programming language version 4.0.3 (2020-10-10), and its open-source IDE RStudio for an easy access of the code. The following packages with respective version are used:

Package	Version
data.table	1.13.2
bit64	4.0.5
bit	4.0.4
plyr	1.8.6
dplyr	1.0.5
haven	2.4.2
ggplot2	3.3.2
missMDA	1.18

Data Collection, Cleaning, and Standardization

The data used by the authors is not fully available because of two reasons:

1. **Data paywall:** Some sociodemographic variables (for instance, education level or income quintile) are not part of the Global Preference Survey, but of the Gallup World Poll dataset. Check the website of the briq - Institute on Behavior & Inequality for more information on it.
2. **Data used in study is not available online:** This is what happened for the log GDP p/c calculated in 2005 US dollars (which is not directly available online). We decided to calculate the log GDP p/c in 2010 US dollars because it was easily available, which should not change the main findings of the article.

An additional issue that we faced while trying to reproduce the results of the article has been the missing data. We will treat this specific issue later on because it requires a bit of background.

The procedure for cleaning is described for each dataset in the corresponding section below. After manually cleaning the dataset, we standardized the names of the countries and merged the datasets into one.

Global Preferences Survey

This data is protected by copyright and can't be given to third parties.

To download the GPS dataset, go to the website of the Global Preferences Survey in the section "downloads". There, choose the "Dataset" form and after filling it, we can download the dataset.

GDP per capita

From the website of the World Bank, one can access the data about the GDP per capita on a certain set of years. We took the GDP per capita (constant 2010 US\$), made an average of the data from 2003 until 2012 for all the available countries, and matched the names of the countries with the ones from the GPS dataset.

Gender Equality Index

The Gender Equality Index is composed of four main datasets. Here below we describe where to get them (as originally sourced by the authors) and how we treated the data within them, if needed.

- **Time since women's suffrage:** Taken from the Inter-Parliamentary Union Website. We prepared the data in the following way. For several countries more than one date were provided (for example, the right to be elected and the right to vote). We use the last date when both vote and stand for election right were granted, with no other restrictions commented. Some countries were colonies or within union of the countries (for instance, Kazakhstan in Soviet Union). For these countries, the rights to vote and be elected might be technically granted two times within union and as independent state. In this case we kept the first date. It was difficult to decide on South Africa because its history shows the racism part very entangled with women's rights [citation]. We kept the latest date when also Black women could vote. For Nigeria, considered the distinctions between North and South, we decided to keep only the North data because, again, it was showing the completeness of the country and it was the last date. Note: USA data doesn't take into account that also up to 1964 black women couldn't vote (in general, Blacks couldn't vote up to that year). We didn't keep this date, because it was not explicitly mentioned in the original dataset. This can be seen as in contrast with other choices made though.
- **UN Gender Inequality Index:** Taken from the Human Development Report 2015. We kept only the table called "Gender Inequality Index".
- **WEF Global Gender Gap:** WEF Global Gender Gap Index Taken from the World Economic Forum Global Gender Gap Report 2015. For countries where data was missing, data was added from the World Economic Forum Global Gender Gap Report 2006. NOTE: We modified some of the country names directly on the csv file, that is why we provide this as an input file.
- **Ratio of female and male labour force participation:** Average International Labour Organization estimates from 2003 to 2012 taken from the World Bank database (<http://data.worldbank.org/indicator/SL.TLF.CACT.FM.ZS>). Values were inverted to create an index of equality. We took the average for the period between 2004 and 2013.

Missing Data and Imputation

During the reproduction of the article, we found that the authors didn't write in details how they handled missing data in the indicators.

They mention on page 14 of the Supplementary Material, that (quoting): "For countries where data were missing data were added from the World Economic Forum Global Gender Gap Report 2006 (http://www3.weforum.org/docs/WEF_GenderGap_Report_2006.pdf)."

However, there are two problems here:

- Regarding the year when women received the right to vote in a specific country. The missing values are the ones coming from the United Arab Emirates and Saudi Arabia, that neither in 2006 (when the WEF Global Gender Gap Report that the authors quote as a reference for the missing values) nor now (in 2021) have guaranteed the right to vote for women yet.
- There are missing data also in the other sources that the authors quote. So a quick search for the missing countries of the WEF report of 2015, shows us that these countries can't be found in the report of 2006 either.

These two unclear points, even though in our understanding not crucial for the replication of the analysis, are not desirable, but couldn't be further clarified with the authors.

The problem of missing data for a given countries often does not influence much the overall trends of found correlations, however, very relevant if one would to see the implications of the study with respect to one certain country of interest.

Data Analysis

The article uses several methods commonly accepted in the field:

- Linear regression for each Country for each preference to extract the gender coefficient as a measure of the gender differences.
- Principal Component Analysis on 6 gender coefficients to summarize an overall measure of the gender differences, and 4 gender equality indexes of the countries to summarize an overall Gender Equality Index.
- Variable Conditioning to separate further between economic development and gender equality in the country.

Linear Model on Each Country for Each Preference

Starting from the complete dataset (meaning with removed NA rows), we wanted to reproduce the data plotted in Fig. S2. regarding the gender differences and economic development by preference and by country.

As already mentioned in the previous paragraph, part of the data to reproduce the article is under restricted access: education level and household income quintile on the individual level are not available in open access version.

As the FH article addresses the gender differences, the main focus is on that individual variable and all the others provided in the dataset (education level, income quintile, age, and subjective math skills) are taken as control variables, meaning that the presence of these variables may not affect the result of the correlation.

In Falk & Hermle (2018b) they check that the role of these variables to any extent negligible in the overall correlation and we therefore decided to continue the analysis without using the two variables education level and household income quintile for building the linear models.

Note that the code can be easily modified to include this variable once the full dataset is available.

The linear model for each country is created using the equation:

$$p_i = \beta_1^c female_i + \beta_2^c age_i + \beta_3^c age_i^2 + \beta_4^c subjective\ math\ skills_i + \epsilon_i$$

This resulted in 6 models – one for each preference measure, p_i – having intercept and 4 weights, each of the weight being related to the variable in the formula above. The weight for the dummy variable “female”, β_1^c , is used as a measure of the country-level gender difference. Therefore, in total, we have 6 weights that represent the preference difference related to the gender for 76 countries.

Principal Component Analysis

To summarise the average gender difference among the six economic preferences, we performed a principal component analysis (PCA) on the gender coefficients from the linear models. The PCA is a dimensionality reduction technique which allows to “reshape” the 6 coefficients into other mixed components that maximise the variance. The first component of the PCA has then been used as a summary index of average gender differences in preferences.

We performed a PCA also on the four datasets used for Gender Equality, to extract a summarised Gender Equality Index (*more on the structure of the constructed Equality Index in section → do we want to have it in the supplementary material together with the critics? Not sure*).

Variable Conditioning

To separate the effects of the economic development and the gender equality, a conditional analysis was performed (Frisch & Waugh (1933), and Lovell (1963)). To generalise, if one wants to estimate the correlation of x and y conditioning on z , one needs to perform a double linear regression:

- First, regressing x on z and extracting the residuals
- Second, regressing y on z , and extracting the residuals.

In the end, one needs to take the so calculated residuals of x on z and of y on z , and make a last regression to calculate the correlation.

In practice, if we are interested in checking the influence of the economic development on the summarised gender differences, conditioning on the gender equality, we would need to regress the economic development on the gender equality index, then the average gender differences regressed on the gender equality index, and finally regress the residuals of the average gender differences on the residuals of the economic development.

3. Comparison to the Original Article

In this section, we describe how to reproduce the plots and compare the results in terms of z -scores.

Reproducing the Plots of the Main Article

To reproduce the plot of Fig. 1A, we grouped the countries in quartiles based on the logarithm of their average GDP p/c, extracted the mean of each preference from the gender coefficients (the β_1^c) of the countries for each quartile, after standardizing them. The same method was applied to the Gender Equality Index in correlation to the gender differences for each economic preference, to reproduce the plot in Fig. 1C.

Then, we related the magnitude of the summarised gender difference coefficients (the first component of the PCA) with the logarithm of the average GDP per capita to see the effect of the economic development. This reproduced Fig. 1B of the original article. We used a linear model to fit the correlation and extract the p -value, and for the plot the variables on the y -axis were additionally transformed as $(y - y_{\min}) / (y_{\max} - y_{\min})$. We applied the same method to extract the correlation between the Gender Equality Index and the summarised gender preference, to see the effect of the gender equality in the countries (Fig. 1D). Note that here also the Gender Equality Index is transformed to be on a scale between 0 and 1.

We finally reproduced the plots in Fig. 2A-F using the variable conditioning analysis. This has been done for the economic development, for the Gender Equality Index, and for each of the four indicators building the Gender Equality Index. The variable used on the y -axis is the first Principal Component of the PCA made on the gender differences on the six preferences. All the variables used have been standardize to have mean at 0 and standard deviation of 1 before applying the conditional analysis. Using the residuals, built as described in the Data Analysis section of the Method paragraph, we performed a linear regression on the data points, and we extracted correlation coefficients and p -values.

Tables and z-scores

The comparison to the original article has been done using the z-scores on the correlation coefficients, and checking if the statistical significance was at the same level. *What about the slope coefficients?*

Here below we report the tables with the corresponding values of the correlation for the original article, our replication study, and the z-scores calculated from them. The sample size of the data, needed for the calculation of the z-scores, is always 76 (the number of the countries involved in this studies), except when using the Gender Equality Index, where due to the missing data, the number of countries in the sample was reduced to 68. *[Check here the sample size of the FH and the number of countries used in the other gender equality indexes!]* We also indicate the significance level for each correlation using the following scheme:

Significance ≤ 0.001 (***), ≤ 0.01 (**), ≤ 0.05 (*)

Table 1: Correlations between Log GDP p/c and country-level gender differences

Variable	Corr. original article	Corr. this analysis	z-score
Altruism	0.58***	0.6***	-0.19
Trust	0.59***	0.53***	0.53
Positive Reciprocity	0.31***	0.29*	0.13
Positive Reciprocity	0.35***	0.42***	-0.50
Risk Taking	0.37***	0.33***	0.28
Patience	0.38***	0.49***	-0.82

Table 2: Correlations between Gender Equality Index and country-level gender differences

Variable	Corr. original article	Corr. this analysis	z-score
Altruism	0.51***	0.49***	0.16
Trust	0.41***	0.47***	-0.44
Positive Reciprocity	0.13	0.20	-0.42
Positive Reciprocity	0.40***	0.30**	0.67
Risk Taking	0.34***	0.26*	0.56
Patience	0.43***	0.48***	-0.37

Table 3: Correlation between Log GDP p/c and Gender Equality Index, and summarised gender differences

Variable	Corr. original article	Corr. this analysis	z-score
Log GDP p/c	0.6685***	0.7119***	-0.46
Gender Equality Index	0.5580***	0.5852***	-0.26

Table 4: Conditional analysis to separate the impacts of economic development and gender equality on gender differences

Variable	Residualized on	Slope coeff. original article	Slope coeff. this analysis
Log GDP p/c	Gender Equality Index	0.5258***	0.5695***
Gender Equality Index	Log GDP p/c	0.3192***	0.2777*
WEF Global Gender Gap	Log GDP p/c	0.2327***	0.2014*

Variable	Residualized on	Slope coeff. original article	Slope coeff. this analysis
UN Gender Equality Index	Log GDP p/c	0.2911	0.2355
F/M in Labor Force Participation	Log GDP p/c	0.2453*	0.1648
Years since Women Suffrage	Log GDP p/c	0.2988**	0.1484

4. Discussion of the Results

Comparing the results of our analysis to the one from the original paper, starting with the single preferences correlations to the economic development, we see that our analysis brings us to very similar results in terms of correlation coefficients (see Table 1). The p-values, although different, are all indicating a statistically significant correlation, as in the original paper, and when calculating the z-scores thanks to Fisher's r to z transformation, we see that each one is below 2 (which is usually taken as threshold to be statistically significant). This means that our correlations were not statistically significantly different from the ones in the original article.

We do the same for the Gender Equality Index (Table 2), and again we don't find any large difference in the correlation. The p-values tend to be different with respect to the original article, but all of them are pointing towards the same direction. Also the z-scores are in absolute values below 2.

In Table 3, we compare the two core concepts of the article, where the summarised gender differences are regressed on the log GDP p/c and on the Gender Equality Index. The correlations found are similarly positive, strong, and statistically significant. Again, the correlations found in our analysis are not statistically significantly different from the correlations found in the original article.

Lastly, we have the conditional analysis (Table 4). For the two main country-level variable, we see that the values tend to agree and be on the same direction (similar slope coefficients and significant p-value). But when we start to check for the single indexes, we see that there are some differences which are worthy to discuss.

The first thing to say is that we had to make choices on how to impute data and also how to handle the missing data (see discussion above in paragraph "Methods"). The main imputation on missing data has been done on the "time since women's suffrage" dataset, that is where we see a substantial difference in the results. Other datasets, on the other hand, has not been treated for missing data but still they present some difference. For instance, the dataset "F/M in Labor Force Participation" in our analysis has a non-statistically significant correlation, while in the original paper they found a correlation with p-value less than 0.05.

A first thought was that this might be the result of using a different dataset for the GDP (the 2010 USD instead of 2005), but in our opinion this can't be an explanation but rather a check about how robust the results are. So this question about the differences that were found is kept open.

Social environment is associated with gene regulatory variation in the rhesus macaque immune system

<https://link.springer.com/article/10.1007/s11199-019-01097-x>

5. Conclusions

The study indicates that higher economic development and higher gender equality are associated with an increase in the gender differences in preferences, and therefore rules out the social-role theory over the post-materialistic one: When more resources are available to both men and women, the expression of the

gender specific preferences can be seen. Our replication leads to the same conclusions, but we have some open questions regarding unexplained differences that might lead to further checks on the results' robustness.

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