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Historical Gender Equality and Economic Development

An update of the Historical Gender Equality Index 1950-2018

By

Marco Hidalgo Ramírez

ma5366hi-s@student.lu.se

To explore the historical relationship between gender equality and economic progress, this study implements two steps. First, it extends the Historical Gender Equality Index (HGEI), a multidimensional measure of gender gaps originally developed by Dilli, Carmichael, and Rijpma (2019). Second, taking advantage of updated HGEI and a comprehensive longitudinal panel data structure, the effects of gender equality on economic development are computed by implementing the Generalized Method of Moments (GMM) estimator of Anderson and Hsiao (1981). Among other potential endogeneity hazards, this quantitative approach rules out the theoretical possibility of reverse causality. Consistent with previous literature, this research provides evidence suggesting that narrowing gender gaps does not have a unique and generalizable economic progress response, instead, it depends on the development stage of each country.

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1 Introduction

> When Adam Smith got his dinner, he didn't think it was because the butcher and baker liked him – he thought it was that their interests were served through trade. It was self-interest that put dinner on the table for Adam Smith.
> Or, was it? Who actually prepared that steak?
> Adam Smith never married. The father of economics lived with his mother for most of his life... Her entire life, she took care of her son, and she is the part of the answer to the question of how we get our dinner that Adam Smith omits (Marçal, 2015, pp.14-15).

As Adam Smith, many other scholars, standard economic models, and the growth literature have historically neglected the role played by women in our societies. Women's work is socially useful, but often not marketed, it then becomes undetectable in the GDP calculation, and therefore it is not accounted for as part of the economic progress (Klasen & Schüler, 2011; Marçal, 2015; Perrin, 2015). This paper, on one hand, arises from the necessity of making visible female historical contributions to the process of economic development.

On the other hand, this research aims to portray the historical social disadvantages faced by women and also to reveal the gender gaps that are still to be closed. Despite the great improvements in the terrain of human rights achieved in recent decades, gender inequality remains to be a reality worldwide, it materializes as wage, intra-household bargaining power, and political representation gaps between men and women, among others. The prevalence of this inequality is particularly high in developing regions like North Africa, South Asia, and the Middle East (Cuberes & Teignier, 2014; Klasen & Lamanna, 2009).

Closing these gaps must be a striking priority globally, indeed achieving gender equality and empowering all women and girls happens to be the fifth -out of a list of seventeen- sustainable development goals proposed by the United Nations. In this regard, this paper is motivated by the conviction that both the promotion of gender equality and the socio-economic empowerment of women are key determinants for the transition to sustained future development.

In this inquiry, I use a cliometric approach to disentangle the empirical connections between gender equality and economic development by responding to the following research question:

> To what extent and under which conditions has the stage of gender equality affected the historical process of economic development after 1950?

To respond to this question, my research follows two objectives. First, to obtain a country-level historical measure of gender (in)equality that covers multiple gender gaps for a globally representative sample during a comprehensive but relatively recent period. Second, with that measure, to implement an empirical strategy that analyzes different effects of gender equality on economic development.

Correspondingly, in this paper, I do two things. Firstly, I extend the Historical Gender Equality Index (HGEI), a multidimensional measure of gender gaps suitable for my analysis; it was originally developed by Dilli, Carmichael and Rijpma (2019). My extension of the index is twofold: I update it until 2018[1], and I improve the underlying imputation process of the HGEI. Secondly, I take advantage of the updated HGEI to approximate the effects of gender equality on economic development. Specifically, I compute several Andersion and Hsiao (1981) Generalized Method of Moments estimations as, among other endogeneity biases, this method rules out the theoretical possibility of reverse causality, meaning development also conditioning gender equality.

My descriptive findings depict which regions and HGEI dimensions have historically been lagging or stagnated across the globe. Consistent with previous literature, my inferential results suggest that there is not a unique and generalizable effect of gender equality on economic progress, instead, it depends on the development stage of the countries. Thus, as a policy implication, future interventions aiming to narrow gender gaps should take into consideration the regional and developmental characteristics of each country to guarantee a positive development response.

The remaining sections of the document are organized as follows. In Section 2, I revisit previous literature on the relationship between gender (in)equality and economic growth, and analyze the features of different measures of gender equality. Section 3 presents the empirical framework, namely, it describes the identification strategy, explains the extension process of the HGEI, and shows several descriptive statistics. The inferential results are discussed in Section 4. Finally, some conclusive remarks can be found in Section 5.

[1] The original HGEI by Dilli, Carmichael and Rijpma (2019) covered the 1950-2003 period. I added 15 years to the sample.

2 Previous literature

2.1 The relationship between gender equality and economic development

Cuberes and Teignier (2014) carried out a meta-analysis on the topic. After revisiting an extensive list of primary scientific studies, they found that the relationship between economic development and gender (in)equality has been theoretically and empirically approached in three different directions described below.

First, economic development could determine gender gaps. The fertility demand analysis developed by Becker (1960), and Becker and Lewis (1973) points in this direction; they stand that when income increases, the opportunity cost of childrearing rises, easing a fertility decline; the consequent incorporation of women into the labor markets narrows the workforce gap between genders and also the educational one, as it enables working women to invest in the human capital of girls. Also, labor market-wise, Greenwood, Seshadri, and Yorukoglu (2005) proposed that industrialization processes allow the existence of "engines of liberation", which are labor-saving technologies in the form of consumer durable goods that let women get rid of their housewife role and incorporate to the labor force; their model is an appreciation of the Second Industrial Revolution, which introduced a shift in the household dynamics with the invention of the washing machines, vacuum cleaners, frozen foods, ready-made clothes, etc.

Furthermore, Doepke and Tertilt (2009), inspired by the female suffrage movements in the 19th century, developed an intergenerational model that explains why men could have incentives for sharing power with women. In their setting, initially, men are in the position to choose women's legal rights. Egoistically, they might be against increasing female rights, since it would represent a loss of marital bargaining power. Nevertheless, altruism appears towards their daughters under situations of economic growth and technological progress, they would vote in favor of female legal rights since they expect an increase in the returns to education. This way, even in the most sexist environments where men only look after each other, fathers ensure the well-being of their sons and sons-in-law by liberating their daughters from patriarchal regimes, since their human capital becomes profitable.

Some empirical literature has supported this theoretical direction. Tzannatos (1999) concluded that economic growth benefits women by easing their incorporation into labor markets. Dollar and Gatti (1999), and Eastin and Prakash (2013) analyzed the effect of economic development on several gender equality dimensions. The two analyses consistently found strong evidence that increments in income per capita lead to improvements in female empowerment, education achievements, health standards, and economic equality. However, both find that the relationship is not linear, it becomes particularly stronger in higher stages of development.

Second, the direction could be the other way around, from gender inequality to economic development. For instance, Esteve-Volart (2004) theorized that individuals are born with a random endowment of entrepreneurial skills, and based on that they choose their accumulation of human capital and whether to become a worker or a manager. In this case, to discriminate women by excluding them from managerial positions (or at all from the labor market) could generate a misallocation of human capital since there is not an optimal use of talent, this diminishes the aggregate output for all, which deteriorates the societal development.

Shultz's (1994) empirical findings fit into this direction of the relationship; his contributions suggest that gender gaps in education lead to an increase in fertility and, consequently, everything else being constant, accelerated population growth could diminish the average income of society. Klasen and Lamanna (2009) consistently found that societal inefficiencies coming from the gender gaps in education and employment are negatively related to economic growth.

Finally, as a combination of both paths above, there could be a two-way relationship between both variables. Galor and Weil (1993), for example, assumed that men are better endowed with physical strength, which leaves women with a comparative advantage in cognitive skills that make them more complementary to physical capital. Under these circumstances, industrialization will make the economy more capital-intensive, benefitting women from a raise in their wages, which would diminish fertility and then generate income growth. Besides, Lagerlöf (2003) proposed that a patriarchal Nash Equilibrium, where is optimal for parents to invest more in the education of their sons than their daughters, is likely to be overcome under economic development. In higher development stages, societies would prefer to re-coordinate towards more egalitarian gender equilibria as a result of women's human capital becoming more profitable, which fosters women to study and work, generating a decline in fertility and, in sum, promoting economic development again.

From the revisited literature, I detected two major takeaways. On one hand, there is not an apparent academic consensus on the direction of the relationship between gender equality and economic development, hence further empirical research should

incorporate the bidirectional possibility in their framework. On the other hand, I found the necessity of using more comprehensive and updated datasets; the longer time spans considered by empirical assessments are Dollar and Gatti (1999), 1960-1990; and Eastin and Prakash (2013), 1980-2005. In this research, I aim to fulfill both necessities.

2.2 Measures of gender equality

To address the research questions in this paper, I needed a systematic measure of Gender Equality that both assesses it in the long-run, and permits a decomposition of its various underlying dimensions. A range of gender-related indicators described below fit into this category.

After developing the Human Development Index (HDI), the United Nations Development Programme (UNDP) pioneered the first attempt to assess cross-country gender gaps by introducing the Gender Development Index (GDI) and the Gender Empowerment Index (GEM) in 1995, which provided an innovative multidimensional description of gender disparities. Nevertheless, these measures present two major shortcomings. First, conceptually, their computation penalizes the HDI depending on the extent of gender inequality experienced by each country, meaning that they are rather gender-inequality-adjusted measures of human development. Second, both face empirical issues regarding the earned income component which is often based on unreliable and uncomparable data (Klasen & Schüler, 2011).

The criticism of these indices motivated some scholars and policy circles to modify the UNDP's (1995) initial approach by generating their own measures. Appendix A documents the most important gender-related indicators, it compares the data extension in dimensions and periods used by each. Dijkstra (2002) designed the Standardized Index of Gender Equality (SIGE), which relativizes the absolute score of each country to the mean score of the full sample, resulting in potential comparability problems over time (Klasen & Schüler, 2011).

Later indices made an effort on increasing the number of variables considered in the calculation beyond four. The Social Watch (2005) collected 10 indicators to compute the Gender Equity Index (GEI), providing a broader picture of gender inequality, however, it is based on shaky income data. Similarly, since 2005 the World Economic Forum has been systematically producing a yearly release of the Gender Gap Index (GGI), unfortunately, as well as the former indicators, it lacks enough data for a long-run analysis (Klasen & Schüler, 2011).

Dilli, Carmichael, and Rijpma (2019) introduced the innovative Historical Gender Equality Index (HGEI, henceforth), a multidimensional measure that captures the relative position of women between 1950 and 2003 in 130 countries. It is the first longitudinal measure of gender (in)equality that covers such a comprehensive historical period. The HGEI is a composite indicator that compiles four areas in which gender inequality is quantitatively documented: health standards, autonomy within the household, political power, and socioeconomic status. Equation (1) describes the computation of the HGEI.

$$(1) \qquad HGEI_{i,t} = \frac{1}{4}\left(Health_{i,t} + Household_{i,t} + Political_{i,t} + Socioeconomic_{i,t}\right)$$

The content of the health component is twofold, as it measures gender inequality in two separate stages of life. For early life stages, the phenomenon of missing women is associated with the preference of boys over girls, it could take the form of induced abortions, infanticide, or neglected young girls. The HGEI parametrizes this with the ratio of girls to boys within the 0-5 age category. For later life stages, the index considers the life expectancy ratio; inequality in this regard could reveal uneven access to food and medical care (Dilli, Carmichael & Rijpma, 2019).

Similarly, the gender socioeconomic disparities are hardly described by a single indicator. Thus, the original authors consider gaps in educational attainment and workforce participation. Education provides human capital for decision-making and influences later development in life, and the employment status is linked to material resources and independence. Both, the health and socioeconomic dimensions, assign to each of its components a different weight, as shown in equations (2) and (3).

$$(2) \qquad Health_{i,t} = \alpha\left(Life\ Expectancy_{i,t}\right) + \beta\left(Sex\ ratio_{i,t}\right)$$

$$(3) \qquad Socioeconomic_{i,t} = \varphi\left(Schooling_{i,t}\right) + \omega\left(Labor\ force_{i,t}\right)$$

Intra-household relations can influence the position of women in their closest social circle. Dilli, Carmichael and Rijpma (2019) approximate the autonomy within the household by using the age gap at first marriage. Everything else being constant, marriages with lower age gaps are more likely to have an even power dynamic within the household; larger age differences might indicate the opposite, arranged child marriages are an extreme example. Additionally, the authors account for the percentage of national parliament seats occupied by women as a proxy for female political power.

Compared to the features of other measures, the HGEI offers a wider scope regarding its multidimensional construction and its coverage in time and space, which makes it the most suitable indicator for a long-run assessment of the relationship between economic development and gender equality.

3 Empirical framework

3.1 Identification strategy

Methodologically, to assess the role of gender equality on economic development, a pooled ordinary least squares (OLS) approach could be suitable in terms of simple interpretability, however, it would probably deliver unreliable estimates not only because there could be an omitted variable bias, but also because both economic development and gender equality could be co-determined, as theoretically suggested by the literature. Thus, to rule out the possibility of endogeneity, especially the reverse causality hazard, I propose considering the following baseline specification:

$$\ln(y_{i,t}) = \alpha_0 + \alpha_1 x_{i,t} + \beta C_{i,t} + \varepsilon_{i,t} \quad (4)$$

The dependent variable uses $y_{i,t}$ which accounts for the real per capita income of country "i" during the year "t". The explanatory variable of interest is $x_{i,t}$, it measures gender equality. $C_{i,t}$ is a vector of control variables widely used in the economic development and growth literature, such as Barro and Sala-i-Martin (2004), and Eastin and Prakash (2013); it includes a lagged dependent variable, population growth, human capital, physical capital investment (%GDP), government expenditure (%GDP), trade openness (%GDP), life expectancy, annual inflation rate, and the democracy level of each country. All the unobservable factors that might determine economic development are considered in the error term, which could be rewritten as:

$$\varepsilon_{i,t} = \sum_{t=1950}^{2018} year_t + n_i + V_{i,t} \quad (5)$$

$$year_t = 1 \ \ iif \ \ year = t, \ \ year_t = 0 \ otherwise \quad (6)$$

The first right-hand side term is a set of year-specific dummies that fulfill the expression (6), which contemplates the possibility of economic development being affected by particular junctures like an economic crisis or a peculiar growth period. The second term, n_i are country time-invariant characteristics that can explain economic development; in case they are also related to the gender equality stage of countries, the OLS coefficient for α_1 is most likely biased. Finally, the term $V_{i,t}$ comprehends all the unobservables that might affect both economic development and gender equality.

A combination of three empirical strategies can be used to deal with the potential endogeneity challenges coming from $\varepsilon_{i,t}$. First, year-specific effects can be controlled by

including year dummies, as suggested by Cuberes and Teignier (2014); these authors also recommended future literature on the topic to implement fixed effects in panel regressions, which would deal with the second component of the measurement error. Third, to tackle the remaining endogeneity possibilities sourcing from $V_{i,t}$, I suggest taking advantage of a longitudinal dynamic panel structure by using a Generalized Method of Moments (GMM) estimator, specifically the Anderson and Hsiao (1981) one. The GMM approach relies on the following two assumptions:

$$(7) \qquad E\left(V_{i,t} \left| x_{i,1}, \dots, x_{i,t}\right.\right) = 0$$

$$(8) \qquad E\left(V_{i,t} \left| x_{i,t+1}, \dots, x_{i,T}\right.\right) \neq 0$$

Contextualizing the equations above, they imply that unexpected random shocks that currently affect the economic development of a country ($V_{i,t}$) are not correlated with the past or current stage of gender equality in that country ($x_{i,1}, \dots, x_{i,t}$); however, these shocks might be correlated to the status of women in the future ($x_{i,t+1}, \dots, x_{i,T}$). For instance, a country that experiences a war or the implementation of a development policy might perceive a contemporary impact on its per capita income, but the effect of these shocks could also determine the position of women in the upcoming years because societies take longer to reallocate the preconceived gender roles in light of the new social and/or economic conditions.

Given those two assumptions, the solution by Anderion and Hsiao (1981) makes feasible the GMM approach by estimating equation (4) using first differences, which gets rid of the time-invariant fixed effects, and instrumenting the potentially endogenous variable of interest by its lagged value. In short, the next equation describes the final chosen model:

$$(9) \qquad \ln\left(y_{i,t}\right) - \ln\left(y_{i,t-1}\right) = \delta\left(x_{i,t} - x_{i,t-1}\right) + \gamma\left(C_{i,t} - C_{i,t-1}\right) + \sum_{t=1951}^{2018}(year_t - year_{t-1}) + \left(V_{i,t} - V_{i,t-1}\right)$$

In equation (9), δ is obtained after using $x_{i,t-1}$ as an instrument for the expression $\left(x_{i,t} - x_{i,t-1}\right)$. This computation is expected to deliver unbiased coefficients as long as the instrument is valid, meaning that it fulfills two conditions. First, it must be relevant, which is easily testable. Second, it must be exogenous, this is guaranteed given the assumption manifested in equation (7).

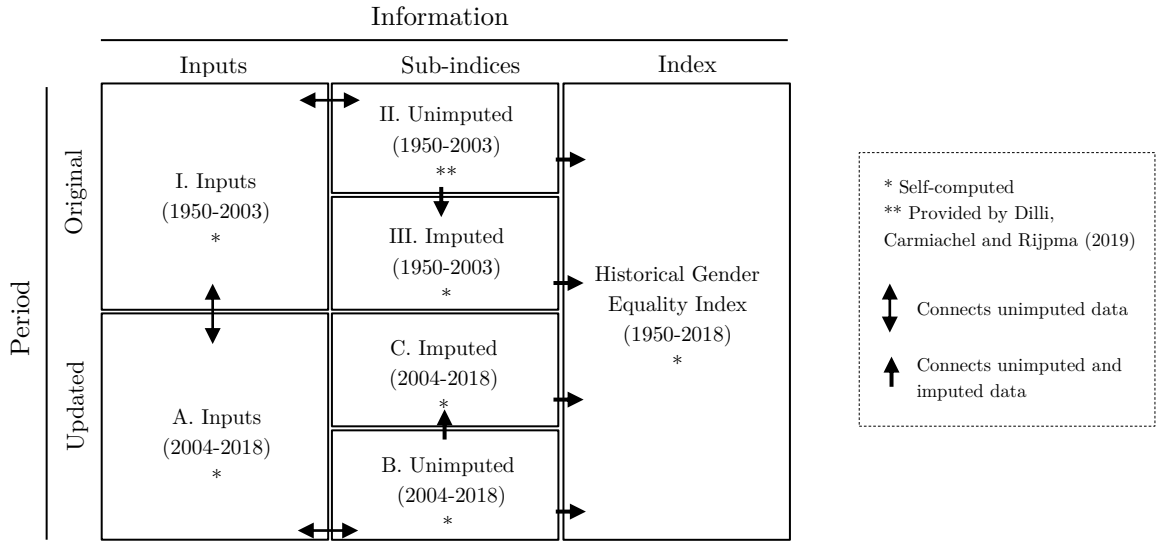
The final results are obtained by combining two possible modifications to equation (9). The first one consists of using the updated HGEI as the proxy for x, or decomposing it as the addition of its underlying components, resulting in a multidimensional estimation. The second adjustment is to split the sample depending on the income level of the countries; this design incorporates insights from Dollar and Gatti (1999) and Eastin and Prakash (2013) who found that the feedback between economic development and gender equality depends on the average income level of each country.

3.2 Data

To estimate the different permutations of equation (9), five major sources were used. The per capita income level, my outcome variable, was obtained in U.S. 2011 dollars from the Maddison dataset (Bolt & Van Zanden, 2020). The 10th release of the Penn World Tables (Feenstra, Inklaar & Timmer, 2015) was used to retrieve some of the control variables: population growth, a human capital index -based on schooling and returns to education-, physical capital investment, and governmental expenditure. The democracy level was captured by the polity score assigned by the Center for Systematic Peace (Marshall & Gurr, 2020). The rest of the controls were collected from the World Bank (2022), namely the annual inflation rate, the openness ratio, and the life expectancy at birth. Finally, for my explanatory variable of interest, I use the HGEI and its dimensions; the creation of the original index belongs to Dilli, Carmichael and Rijpma (2019), and I updated it for this research as explained in the next sub-section.

3.2.1 Updating the Historical Gender-Equality Index

Figure 1: Data management procedure



To update the HGEI, three levels of information were managed in both, the period covered in the original index release, 1950-2003; and the updated one, 2004-2018. Figure 1 depicts the procedure. Initially, using only primary sources, the four gender equality sub-indices were calculated without imputations -as in panels B and II in the figure-. The resultant data was patchy, thus to ensure full coverage over time and space, the missing values -in panels III and C- were predicted using imputation techniques that take into account the observed historical behavior of each sub-index and some

additional explanatory variables or "inputs" -panels I and A-. Altogether, the imputed and unimputed dimensions were used to compute the updated HGEI.

Sub-indices sources

The data collection for the 1950-2003 period was not necessary, since the gender equality unimputed sub-indices were retrieved from the original authors. For the updated period, although the proxy for each dimension is consistent with those from Dilli, Carmichael and Rijpma (2019), the data sources did change.

The United Nations (2019a, 2019b) have documented historical country records on life expectancy at birth and the ratio of girls to boys that were used to compute the health sub-index; as well as the mean age at first marriage used as a proxy for the power within the household indicator. The political power dimension was proxied by the ratio of female to male seats on national parliaments available on the World Development Indicators platform from the World Bank (2022). Finally, the socioeconomic sub-index contains two types of gender gaps. On the one hand, it covers differences in schooling outcomes approximated by the average school years obtained by people 25 and older, this was collected from Barro and Lee (2013) and the United Nations Development Programme (UNDP, 2020). On the other hand, it captures gender inequalities in the labor market as the labor force participation ratio tracked by the World Bank (2022).

As a selection criterion, those observations that lacked data on the six indicators at a time were dropped, which let the final sample with 130 countries, although that number changes to 127 in the updated period as Czechoslovakia, Yugoslavia, and the USSR become inexistent in the historical records. Table 1 summarizes the different sources and some pre-imputation descriptive statistics of each component.

Computation

After collecting the raw data of each component, a six-step methodology was followed. This procedure not only gives continuity to the original author's approach but also is consistent with the construction of other gender-related indices such as the national-level Gender Gap Index and the Swedish counties' Gender Gap Index, constructed by the World Economic Forum (2005, 2021) and Karlsson, Kok, and Perrin (2021), respectively. Besides, the methodology ensures that the final index fulfills three ideal conditions for a gender (in)equality measure, according to Dijkstra (2002, p.317):

1. It should contain a small number of indicators that, as a whole, represent all the relevant dimensions of gender equality.
2. It should be a relative measure rather than a combination of absolute well-being and inequality measures.
3. The construction of the index should assign the same importance to each component.

Table 1: Sources and summary statistics of the HGEI components before imputation

Indicator	Description	Range*	Mean (SD)*	Countries	Years	Source
Original Index data						
HGEI	Historical Gender-Equality Index	0.47-0.80	0,65 (0.05)	130	1950-2003	Dilli, Carmichael and Rijpma (2019)
Sub-indices				130	1950-2003	
Updated data						
a. Health						
Life expectancy	Life expectancy at birth ratio	0.96-1	0.99 (0.01)	127	2004-2018	United Nations (2019b)
Sex Ratio	Ratio of females to males, ages 0-5	0.91-1	1 (0.01)	127	2004-2018	United Nations (2019b)
b. Autonomy within the household	Age at first marriage ratio	0.51-0.97	0.88 (0.06)	122	2004-2018	United Nations (2019a)
c. Political power	Ratio of seats held in parliament	0-1	0.28 (0.20)	127	2004-2018	World Bank (2022)
d. Socioeconomic status						
Schooling	Average years of schooling ratio, ages 25 and older	0.23-1	0.87 (0.17)	127	2005, 2010, 2015 2011-2018	Barro and Lee (2013)** UNDP (2020)
Labor force	Labor force participation ratio, ages 15 and older	0.09-1	0.70 (0.20)	127	2004-2018	World Bank (2022)

* The summary statistics were computed after truncating the ratios to 1 (See Step 3 in the construction of the index)

** Barro and Lee's (2013) dataset was updated until 2015 on the version 3.0 published on 2021

The six steps operate as follows:

Step 1: Conversion to ratios - Considering that the HGEI aims to assess the position of women relative to men instead of the levels of available resources or opportunities for women (Dilli, Carmichael & Rijpma, 2019), as a first step, all the data is converted into female-to-male ratios. This allows a straightforward interpretation of the index within a 0-1 spectrum where 1 represents perfect between-gender equality; alternatively, the difference between an index score and the value of one could be understood as the gender gap for a particular dimension in a given time and place.

Step 2: Data rescaling at the equality benchmark – According to the World Population Prospects (United Nations, 2019b), there are two well-documented demographic statements supported by biological evidence (Ritchie & Roser, 2019). Firstly, the sex ratio at birth is not equal, the expected natural value is 105 boys per every 100 girls. Secondly, on average, women tend to live five years longer than men. Consequently, setting 1 as the gender equality scenario would bias downwards (upwards) the life expectancy (sex) ratio; therefore, the data is rescaled such that 1.06 (0.94) is taken as the equality benchmark for this indicator.

Step 3: Truncation to 1 – The index equally rates a country that achieved perfect gender parity and another in which women relatively have surpassed men. Thus, ratios above the unity are truncated to 1. Not only this is convenient for the index specification, but also the situations where men are disadvantaged compared to women are comparably scarce. Indeed, Table 2 reports the overall advantage performed by both genders in each dimension during the updated period. Noticeably, women tend to underperform in all the well-being standards, except in health outcomes (even after adjusting for the equality benchmark explained above); whereas men, on average, over-perform in 66% of the cases.

Table 2: Relative wellbeing performance by gender, 2004-2018

Indicator	Cases	Scenario (%)		
		Male advantage	Equality	Female advantage
Health				
Life expectancy	3045	40.43	0	59.57
Sex Ratio	3015	19.8	0	80.2
Autonomy within the household	775	99.48	0	0.52
Political power	2814	99.25	0.14	0.6
Socioeconomic status				
Schooling	1639	67.24	3.78	28.98
Labor force	2774	98.89	0	1.11
Case-weighted average		65.69	0.47	33.84

Source: author's calculations

Moreover, situations where women have an advantage over men in a particular living standard should not divert the focus from the overall gender gap panorama. For instance, narrowing the gender gaps in education could become an ineffective policy if there still are broad barriers for women in the labor market (Cuberes & Teignier, 2014); alternatively, higher female scholar achievements might also reflect that women have to accumulate more human capital than men to receive the same working conditions.

Step 4: Imputation of the missing values - The "Amelia II" algorithm developed by Honaker, King, and Blackwell (2011) was implemented to guarantee a more comprehensive panel-data scope over time and space suitable for a long-run analysis, and to recover data that otherwise would have provoked bigger information losses due to the "listwise deletion" mechanism, which removes any row that contains a missing value on most statistical software.

Amelia II is programmed as a publicly available R package. It uses an expectation-maximization with bootstrapping technique that considers multiple bootstrapped samples of the initial incomplete panel to obtain several predictive parameter sets of the complete panel; then it forecasts different imputed values from each set of bootstrapped parameters and replaces the missing observations with those predicted values (Honaker, King & Blackwell, 2011).

The missing values of the sub-indices for the full 1950-2018 were retrieved settling Amelia II with two features. First, the software takes advantage of the panel structure of the data, as it distinguishes the cross-sectional and the time-series variables which enables it to include time-invariant country-specific effects for better predictive modeling. Second, to ensure more accurate imputations, I endowed Amelia II with a set of improved auxiliary variables originally proposed by Dilli, Carmichael and Rijpma (2019), which are listed in Table 3.

Table 3: Auxiliary variables used for the imputation

Variable	Source
Religious composition	
% Muslims	Correlates of War Project (Maoz & Henderson, 2013) and the Pew Research Center (2015)
% Protestants	
% Catholics	
Socioeconomic characteristics	
Per capita income, in 2011 U.S. dollars	Maddison Project Database (Bolt & Van Zanden, 2020)
Oil rents (% GDP)	World Development Indicators (World Bank, 2022)
Education expenditure (%GDP)	
Percentage labor force employed in the industrial and service sectors	
Fertility rate	
Democracy stage: polity score	Center for Systematic Peace (Marshall & Gurr, 2020)

The wider historical coverage of my data coupled with an enhanced set of input variables allowed me to compute more precise predictions of the missing values compared to the original release of the index. This way, apart from expanding the HGEI until 2018, my contribution to it also consists of improving the accuracy of the imputations. For this reason, there are slight differences between my imputed values and the ones from Dilli, Carmichael, and Rijpma (2019) during our overlapping period, 1950-2003; Appendix B summarizes the differences between both sets of estimates.

Step 5: Computation of the weights - Within the composed sub-indices, namely health and socioeconomic power, averaging the underlying individual indicators would imply assigning higher weights to measures with larger volatility (World Economic Forum, 2021). To offset this characteristic, these composed indicators are calculated as the average of their components weighted by their inverse standard deviation. This technique is better than estimating a simple average because it allows these particular sub-indices to reward their most stable element and prevents them to be largely driven by extreme changes in their most unstable element.

As an example, within the health sub-index, the life expectancy ratio exhibits a higher variability than the sex ratio, since their standard deviations are 0.029 and 0.017, respectively. Thus the computation designated life expectancy a 36% weight within the final health sub-index; the remaining 72%, to the sex ratio. Further detail can be found in Table 4.

Table 4: Summary statistics of the HGEI components after imputation, 1950-2018

Indicator	Min	Max	Mean	Std. dev.	Countries	Weight within	
						Sub-index	HGEI
a. Health							
Life expectancy	0.80	1	0.98	0.029	130	0.36	0.09
Sex ratio	0.83	1	1.00	0.017	130	0.72	0.16
Total	0.88	1	0.99	0.015	130	1	0.25
b. Autonomy within the household	0.51	0.98	0.85	0.056	130	1	0.25
c. Political power	0	1	0.14	0.154	130	1	0.25
d. Socioeconomic Status							
Schooling	0.03	1	0.74	0.223	130	0.48	0.12
Labor force participation	0.01	1	0.59	0.220	130	0.52	0.13
Total	0.08	1	0.66	0.1784	130	1	0.25
Historical Gender Equality Index	0.43	0.97	0.66	0.0816	130		1

Source: author's calculations

Step 6: Calculation of the final index - The final step involves computing the unweighted arithmetic mean of the four sub-indices. As a result, the final database consists of an unbalanced panel data that covers 130 countries over the 1950-2018 period. To the best of my knowledge, at the time there is no other data source with such a comprehensive historical assessment of gender (in)equality across countries.

3.2.2 Shortcomings of the index

A common drawback of multidimensional indices has to do with their specification. In this regard, Klasen & Schüler (2011) argued that arithmetic averages are rather imprecise since "doing twice as well in one component (that is, with the ratio being 2) more than compensates for doing half as well in another component (that is, with the ratio being 0.5), clearly a counterintuitive result" (p. 6); instead, they proposed a geometric average as an alternative.

Two counter-arguments contrast the former viewpoint. First, implementing the ratios truncation to 1 prevents the overcompensation outside of the 0-1 range. Second, using a geometric specification would most likely result in HGEI values largely downward driven by the historical low political representation of women, meaning that the significant achievements in the rest of the indicators would be neglected (Dilli, Carmichael & Rijpma, 2019).

Figure 2 provides a graphic sensitivity test that empirically supports the choice of arithmetic over the geometric specification. In general, the geometric HGEI understates the arithmetic one disregarding the geographic unit analyzed, as shown in panel "c". The gap between both calculations broads in countries and/or times of backward gender equality accomplishment. Niger and Sweden, which are respectively ranked as the most and least unequal countries for women in my sample (see Table 5), exemplify this in panels "a" and "b". Over the 60s decade, the geometric HGEI in Niger is completely penalized, lowering the index to the value of zero, for having an absent representation of women in parliament, although women experienced around 50% of equality in the other dimensions. Even in Sweden, both indices only converge after the beginning of the 21st century.

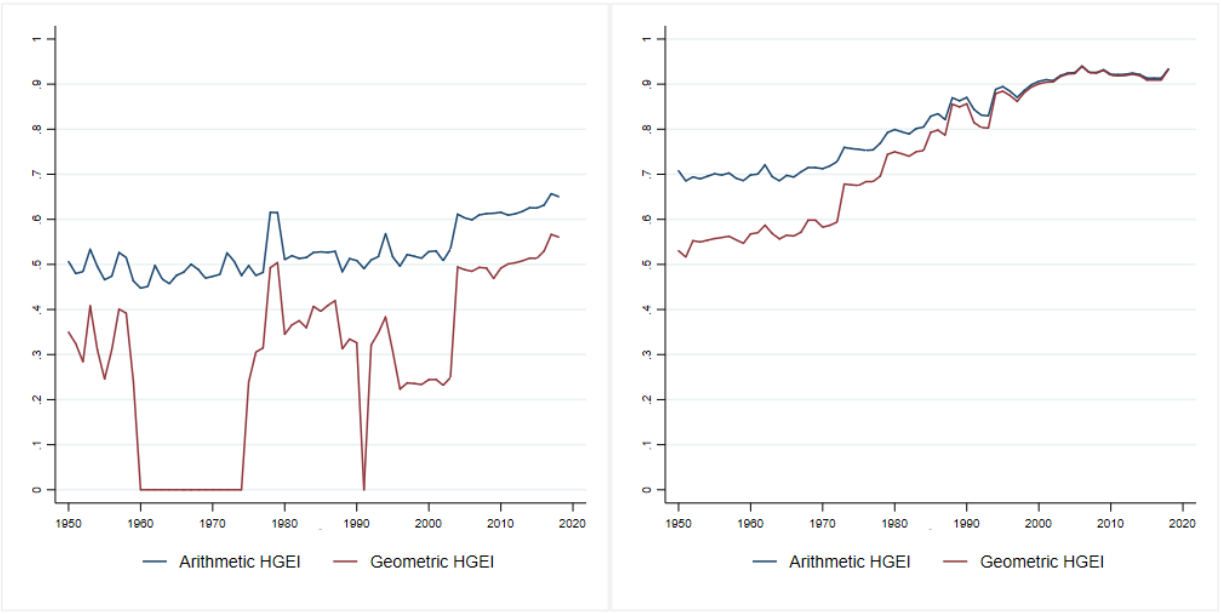
Additionally, there are at least three identified critical shortcomings of the HGEI. In the first place, regarding its interpretation, an increase in the index score could be due to a combination of an improvement in the absolute position of women and a worsening in that of men; as a relativized measure, the HGEI is unable to determine the leading source of its numerical enhancement. In the second place, gender inequality might affect women at both macro and micro levels, as a country-level composite indicator, the HGEI accounts only for the macro ones (Dilli, Carmichael & Rijpma, 2019); recent

important contributions, like Karlsson, Kok and Perrin (2021), have assessed gender gaps with a more disaggregated approach.

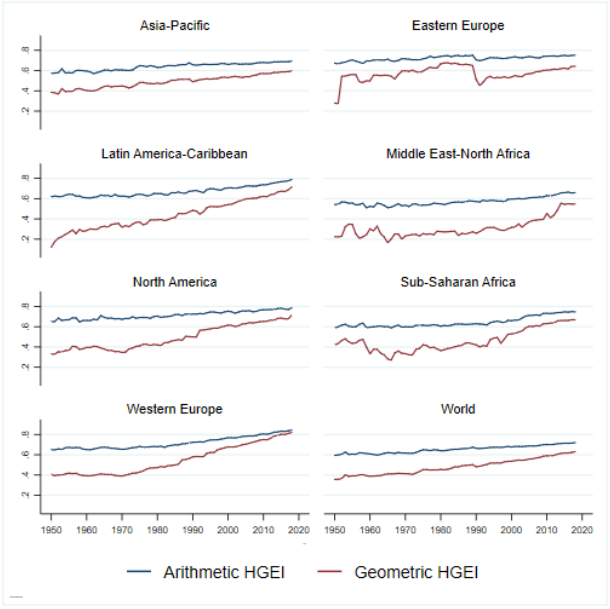
Figure 2: Specification sensibility test in different locations

a. Niger

b. Sweden



c. World Regions



Source: author's calculations

Lastly, the HGEI does its best on compiling a set of variables that approximate gender disparities, but it fails to capture the complete panorama as it misses several unobservables. If there were no data constraints, better proxies would have been

considered. For instance, time-usage information or bargaining power within the household would have been preferred over the marriage age ratio; similarly, a broader measure of the role of women in national institutions would have captured female political power better than the share of women in parliaments.

Moreover, the wage gap most likely plays a big role in economic inequalities in every society, however, there was not a reliable source found that historically records earned income differences across the globe, hence the labor force participation ratio was considered the second-best option. Nevertheless, as indicated by Klasen and Schüler (2011), this substitute is not without problems. Namely, openly unemployed people looking for jobs are taken into account in this measure; it excludes socially useful but not marketed activities like home production and care activities; and there is uncertainty about the accountability of informal labor markets.

3.2.3 Descriptive statistics

The updated HGEI can be used in a diversity of ways. It tracks gender disparities over time and space to several extents since it could be aggregated to international levels, it could be expressed in levels or growth rates, and it could be analyzed individually but also decomposed by each of its dimensions. This sub-section performs a combination of these descriptive assessments.

Country-level

It could be hard to dimension the nuances of gender equality on a database that covers 130 countries, the majority of them for 69 years. To ease the process, Table 5 ranks the countries according to their average HGEI score in each decade; three interesting insights can be derived from it.

First, over the last 7 decades the upper tail of the distribution has experienced a substantial improvement, whilst in the 1950s women in the most equalitarian environments lived with 73% of male standards, this number improved to almost 95% in the 2010s. However, the lower tail of the distribution has almost stagnated, the multidimensional gender gap has barely shifted from 51% to 48% during these years.

Second, during the observed period, the highest positions in the ranking are highly dominated by five Northern European countries: Sweden, Finland, Norway, Denmark, and the Netherlands. Iceland, which could be expected to be on this list, is not included in the sample due to data availability. There are two important exceptions to the northern rule: the USSR and Czechoslovakia before their disintegration in the 90s, and

the amazing performance of Rwanda, this country has managed to catch up with the leading countries over the last two decades.

Third, there is historical stability in the last positions of the ranking usually occupied by countries in the Middle East and North Africa (MENA, hereafter) region; Niger, Yemen, Afghanistan, Pakistan, and Jordan are regularly found to be to most unequal countries for women over the sample.

Beyond considering the final HGEI score, one could be interested in how countries moved on compared to their departure point regarding gender equality. For this purpose, Table 6 ranks countries based on their HGEI decadal growth, this is comparing the score at the beginning and end of each decade. In this case, there is not a distinguishable pattern of the tails of the distribution; although some countries report deterioration of gender equality in specific decades, only Yemen and Hungary were in 2018 a worse situation than in 1950.

Contrastingly, the most equal countries for women, in Table 5, do not coincide with countries that achieved the biggest improvements in gender equality, in Table 6. This fact could raise questions about the possibility of convergence, meaning that HGEI lower-ranked countries could be catching up with the leaders since they perform more rapid improvements in gender equality standards.

Figure 3 aims to graphically test the convergence hypothesis. Overall, there is a negative correlation among the initial level of the HGEI and its growth rate between 1950 and 2018; this also applies to all the sub-indices, especially to the health ratio in panel "b". This should provide some hope to countries that seem to be falling behind in this field, as the historical evidence shows that every step in the direction towards gender equality has increasingly made them converge to the standards of the most progressive nations.

The striking outlier growth of two countries draws attention in Figure 3. Panel "c" shows that by 1950 the socioeconomic gender gap in Libya was 91%, but in 69 years the country managed to improve the relative position of women relative to men by 731% in this regard. More impressively, Spain improved by more than twenty-one thousand percent the political representation of women relative to men after departing from almost no women in parliament in 1950 (see panel "d")

Table 5: HGEI decadal average score ranking

Performance	1950s		1960s		1970s		1980s	
Highest		score		score		score		score
1	USSR	0.730	USSR	0.758	USSR	0.789	Sweden	0.821
2	Finland	0.713	Hungary	0.725	Czechoslovakia	0.764	Finland	0.806
3	Hungary	0.705	Finland	0.722	Finland	0.762	Norway	0.796
4	Mongolia	0.700	Bulgaria	0.720	Hungary	0.755	Romania	0.785
5	Czechoslovakia	0.697	Czechoslovakia	0.715	Sweden	0.750	Denmark	0.783
6	Jamaica	0.697	Romania	0.709	Albania	0.735	Czechoslovakia	0.778
7	Romania	0.696	Mongolia	0.707	Vietnam	0.734	Hungary	0.777
8	Sweden	0.695	Poland	0.703	Poland	0.731	USSR	0.773
9	Bulgaria	0.695	Sweden	0.703	Bulgaria	0.730	Albania	0.753
10	Poland	0.689	Norway	0.683	Denmark	0.724	Cuba	0.744
Lowest								
10	Egypt	0.524	Algeria	0.533	Libya	0.540	Iran	0.554
9	Mali	0.523	Pakistan	0.526	Syria	0.539	Jordan	0.554
8	India	0.519	Iran	0.526	Mali	0.535	Saudi Arabia	0.553
7	Afghanistan	0.516	Tunisia	0.518	Jordan	0.525	Algeria	0.542
6	Iran	0.510	Egypt	0.511	Egypt	0.524	Bangladesh	0.533
5	Bangladesh	0.508	Bangladesh	0.508	Niger	0.514	Mali	0.531
4	Iraq	0.507	Libya	0.506	Yemen	0.514	Afghanistan	0.517
3	Libya	0.502	Afghanistan	0.502	Pakistan	0.509	Niger	0.516
2	Niger	0.494	Jordan	0.501	Bangladesh	0.507	Yemen	0.515
1	Jordan	0.492	Niger	0.474	Afghanistan	0.490	Pakistan	0.512

Performance	1990s		2000s		2010s (until 2018)		Overall 1950-2018	
Highest		score		score		score		score
1	Sweden	0.870	Sweden	0.922	Rwanda	0.948	Sweden	0.810
2	Norway	0.853	Rwanda	0.873	Sweden	0.921	Finland	0.801
3	Finland	0.847	Finland	0.869	Finland	0.901	Norway	0.780
4	Denmark	0.832	Denmark	0.859	Cuba	0.899	Denmark	0.773
5	Netherlands	0.783	Norway	0.858	Norway	0.890	Netherlands	0.745
6	New Zealand	0.768	Netherlands	0.844	Denmark	0.874	Cuba	0.745
7	Germany	0.763	Belgium	0.813	South Africa	0.872	Bulgaria	0.734
8	Cuba	0.755	New Zealand	0.812	Belgium	0.863	Hungary	0.732
9	Canada	0.752	Germany	0.811	Netherlands	0.862	Poland	0.732
10	Austria	0.752	Argentina	0.810	Spain	0.857	Germany	0.731
Lowest								
10	Egypt	0.572	Mali	0.604	Morocco	0.629	India	0.565
9	Saudi Arabia	0.571	Jordan	0.603	Syria	0.628	Iran	0.565
8	Mauritania	0.566	Algeria	0.600	Niger	0.627	Bangladesh	0.560
7	Algeria	0.564	Bangladesh	0.595	Mali	0.624	Mali	0.556
6	Sierra Leone	0.560	Saudi Arabia	0.593	Pakistan	0.622	Egypt	0.556
5	Mali	0.541	India	0.590	Iran	0.619	Jordan	0.555
4	Yemen	0.527	Egypt	0.587	Egypt	0.619	Pakistan	0.546
3	Afghanistan	0.524	Afghanistan	0.576	Afghanistan	0.615	Afghanistan	0.533
2	Pakistan	0.524	Niger	0.575	India	0.591	Yemen	0.530
1	Niger	0.516	Yemen	0.536	Yemen	0.524	Niger	0.530

Source: author's calculations

Table 6: HGEI decadal growth rate (%) raking

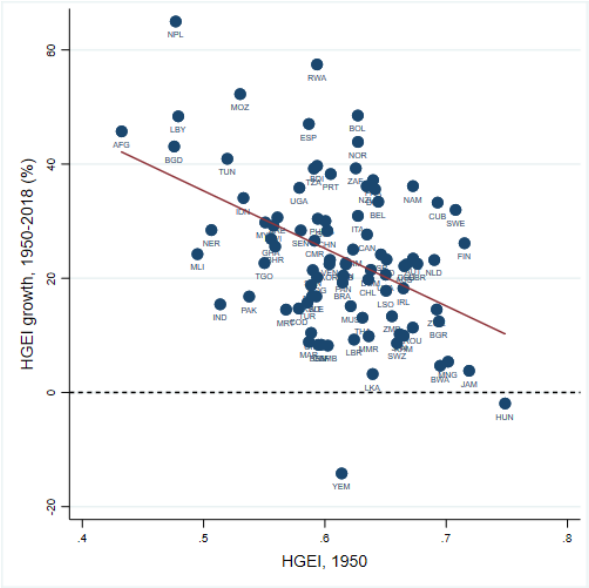
Performance	1950s		1960s		1970s		1980s	
Highest		%		%		%		%
1	Greece	15.11	Namibia	21.84	Niger	29.89	Bangladesh	24.85
2	Colombia	14.41	Bangladesh	18.38	Cuba	19.82	Libya	20.99
3	Iran	13.36	Iran	13.34	Mozambique	16.75	Rwanda	18.97
4	Afghanistan	12.36	Greece	12.60	Jamaica	15.74	Saudi Arabia	15.60
5	Peru	10.65	Syria	12.34	Iran	15.06	Paraguay	14.93
6	China	9.84	Cote d'Ivoire	12.15	Denmark	14.18	India	13.74
7	USSR	9.59	El Salvador	11.19	Norway	12.17	Cuba	13.05
8	Nepal	9.34	Iraq	10.92	Portugal	11.76	Un. Arab Em.	12.15
9	Iraq	8.56	Honduras	10.41	El Salvador	11.62	Nepal	12.00
10	Vietnam	8.41	Guatemala	10.08	Sweden	11.23	Afghanistan	11.99
Lowest								
10	Dom. Rep.	-7.84	Sri Lanka	-5.58	Cote d'Ivoire	-4.83	Togo	-4.09
9	Mongolia	-7.86	Malawi	-5.74	Honduras	-5.43	Uruguay	-4.14
8	Niger	-8.53	Sudan	-7.64	Bangladesh	-5.79	Yemen	-4.23
7	Algeria	-8.72	Gambia	-7.99	Ghana	-6.26	Cote d'Ivoire	-4.74
6	Cuba	-8.82	Lesotho	-8.72	Costa Rica	-7.08	Chile	-5.49
5	Sudan	-9.31	Kenya	-9.79	Qatar	-7.11	Haiti	-6.10
4	Yemen	-9.32	Kuwait	-12.17	Bolivia	-7.23	Central Africa	-6.74
3	Namibia	-11.50	Zambia	-14.08	Pakistan	-7.80	Eswatini	-6.99
2	Morocco	-11.51	Algeria	-14.82	Benin	-8.68	Mauritania	-7.28
1	Syria	-11.64	Jamaica	-16.61	Myanmar	-12.73	USSR	-11.98

Performance	1990s		2000s		2010s (until 2018)		Overall 1950-2018	
Highest		%		%		%		%
1	Argentina	16.33	Rwanda	34.62	Bolivia	23.49	Nepal	64.98
2	South Africa	16.16	Burundi	21.36	Nicaragua	19.78	Rwanda	57.45
3	Bolivia	14.36	Uganda	18.48	Mexico	19.40	Mozambique	52.26
4	Lithuania	13.36	Nepal	17.53	Namibia	17.05	Bolivia	48.51
5	Nepal	11.93	Mozambique	17.19	Senegal	15.69	Libya	48.36
6	Afghanistan	11.36	Cameroon	17.03	France	14.72	Spain	47.03
7	Mozambique	11.24	Tanzania	16.60	Algeria	14.55	Nicaragua	46.66
8	Netherlands	11.04	Niger	16.12	Zimbabwe	10.77	Afghanistan	45.72
9	Moldova	10.80	Sierra Leone	16.10	Saudi Arabia	10.33	Norway	43.88
10	Qatar	10.80	Afghanistan	14.85	Italy	9.79	Mexico	43.79
Lowest								
10	Mauritania	-3.64	Iran	-1.35	Tajikistan	-1.31	Central Africa	8.36
9	Eswatini	-3.70	Syria	-1.37	Thailand	-1.89	Benin	8.35
8	Cuba	-4.09	Mongolia	-1.88	Eswatini	-2.10	Gambia	8.21
7	Gambia	-4.12	Vietnam	-1.88	Benin	-2.21	Mongolia	5.38
6	Bahrain	-4.23	Jamaica	-1.92	South Africa	-2.25	Botswana	4.68
5	Cameroon	-4.28	Yemen	-2.02	Netherlands	-3.13	Haiti	4.05
4	Lithuania	-4.42	Estonia	-2.22	Croatia	-3.28	Jamaica	3.79
3	Burundi	-6.32	Botswana	-3.17	Rwanda	-3.33	Sri Lanka	3.23
2	Sierra Leone	-8.31	Myanmar	-4.50	Kyrgyzstan	-4.85	Hungary	-1.93
1	Albania	-13.64	Colombia	-6.67	Mali	-8.76	Yemen	-14.19

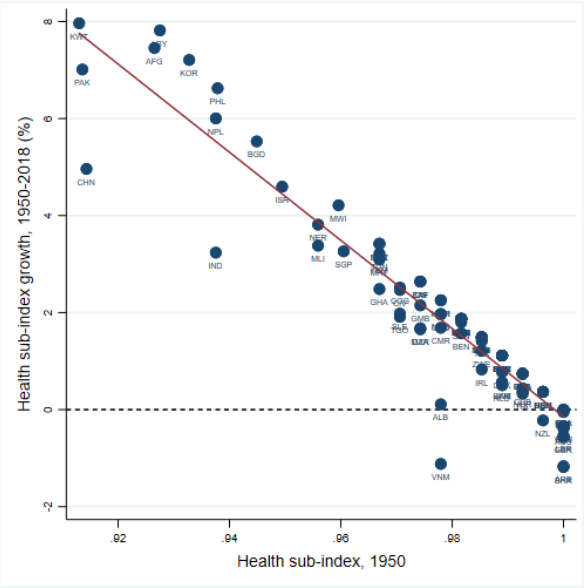
Source: author's calculations

Figure 3: HGEI and its components in levels and growth, 1950-2018

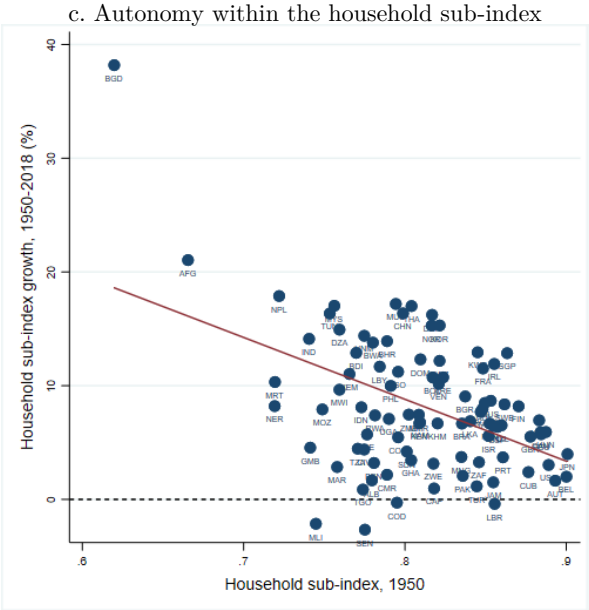
a. HGEI index



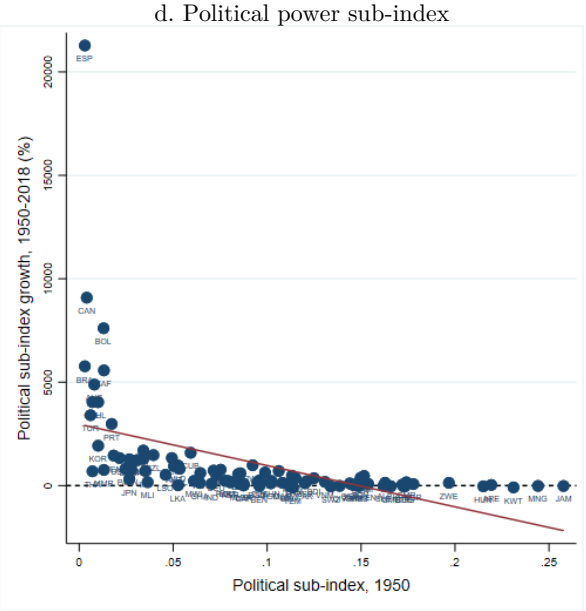
b. Health sub-index



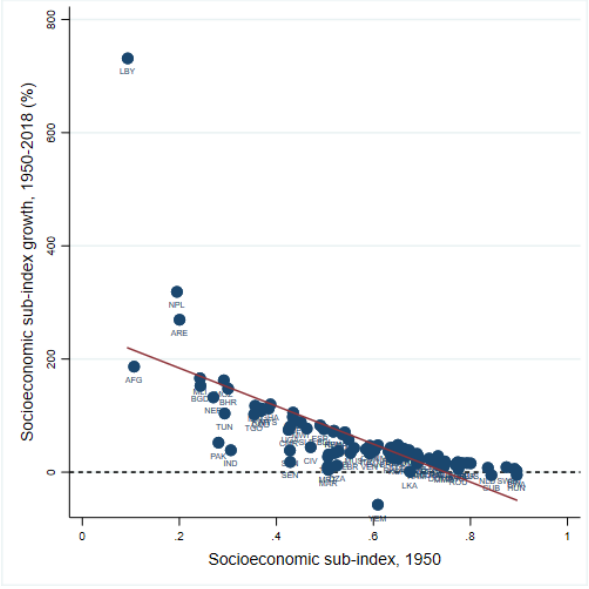
c. Autonomy within the household sub-index



d. Political power sub-index



c. Socioeconomic sub-index



Source: author's calculations

Aggregate-level

The values in Figure 4 and Figure 5 correspond to averages weighted by their annual populations. This implies that, within a region, relatively lower populated countries contribute less to aggregated indices. In every panel, the world index is included to relativize each region with the entire globe.

Figure 4 describes the HGEI trajectory by geographic region in four panels. Panel "a" documents the HGEI similarities and differences between regions. Evaluating the global indicator, between 1950 and 2018 the gender gap narrowed from 41% to 29%. However, the world's HGEI is not always representative. It roughly fitted the performance of Latin America, Asia and Pacific, and Sub-Saharan Africa until the 90s, after that these regions grew apart; the rest of the regions have always shown dissimilar patterns.

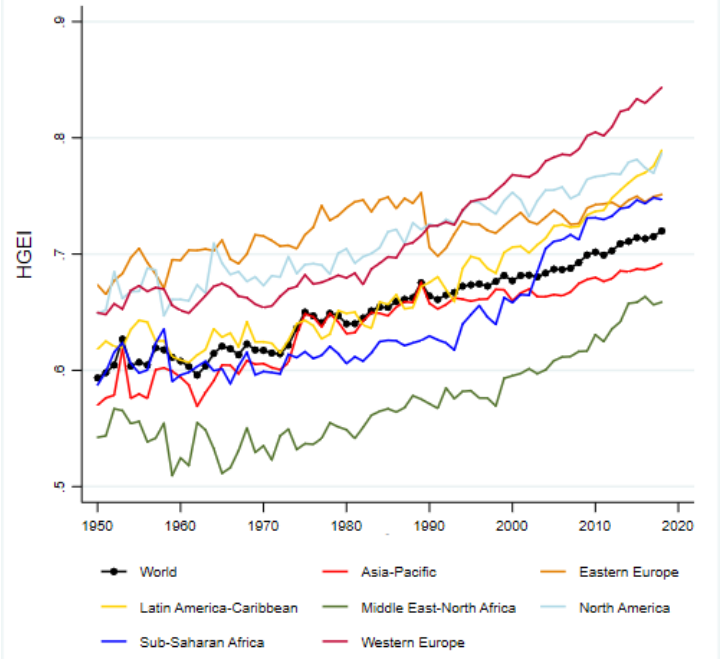
Until the mid-1990s, Eastern Europe was the most progressive region judging by the HGEI; after the disintegration of the Soviet bloc, Western Europe took off as the leading region in terms of gender equality and has remained like that afterward. Conversely, the MENA region has consistently reported the most unequal standards for women until recent times; indeed by 2018 women in that region lived with the HGEI levels that Western European women had in 1969, meaning that the MENA region is lagging behind modern Western Europe by 49 years. Analogously, Asia-Pacific lags 34 years behind; Sub-Saharan Africa, 22; Eastern Europe, 20; and North and Latin America, 10 years.

In panel "b", the HGEI is decomposed in each of its dimensions. As a common fact between the regions, the order of the sub-indices from most to least equal behaves as follows: health, autonomy within the household, socioeconomic power, and political representation. In terms of magnitudes, over 69 years women in all regions have accounted for nearly the same health standards as men, making it the leading dimension of gender equality; whereas the autonomy within the household sub-index has gravitated around 80-90 percent.

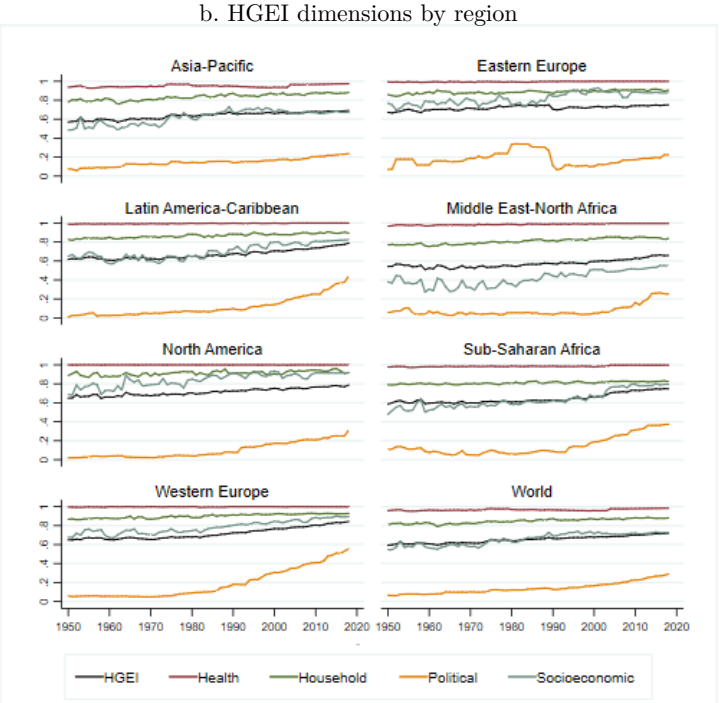
The socioeconomic dimension historically presents the highest volatility between and within the regions. In North America and Europe, this sub-index is always placed above the HGEI line, meaning that the outcomes achieved by women in terms of schooling and workforce were more equalitarian than the overall panorama. In Asia-Pacific, Latin America, and Sub-Saharan Africa those outcomes were as unequal as the full overview. Nonetheless, in the MENA region, the socioeconomic status of women has remarkably been unfair compared to men. On the other hand, the political representation has evenly been the most unequal dimension for women worldwide, but favorably there is a steep improvement after the 1990s in this matter.

Figure 4: HGEI descriptive statistics by geographic region, 1950-2018

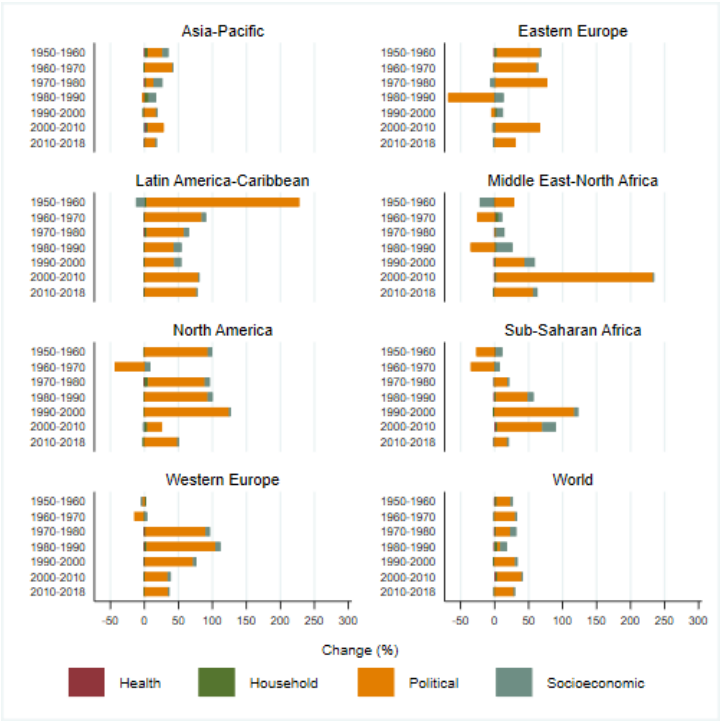
a. HGEI performance per region



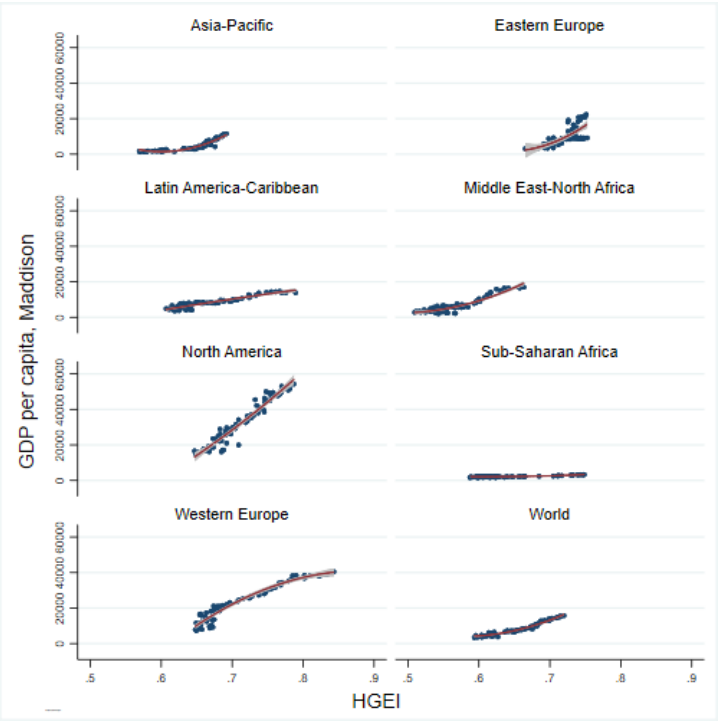
b. HGEI dimensions by region



c. Drivers of HGEI growth by region



d. HGEI and economic development by region



Source: author's calculations

As observed in panel "b", while some dimensions lead the HGEI levels, others lag behind; however, their contributions to the improvement of gender equality, i.e. the growth of the index, might differ. To estimate the individual contribution per dimension to the progress in the field, the following equation can be computed. Using low case to denote variation rates,

$$(10) \quad hgei_{i,t} = \frac{1}{4}\left(health_{i,t} + household_{i,t} + political_{i,t} + socioeconomic_{i,t}\right)$$

Panel "c" in Figure 4 depicts the total derivate represented by equation (10). There is a clear dominance of political power, which makes it the historical driver dimension of the improvement of gender equality over the 7 examined decades in every region, meaning that the growth achieved in the HGEI scores has mainly been explained by advancements in the representation of women in politics.

An explanation for the apparent contradictive findings from panels "b" and "c", is that since the 1950s there was little scope left for improvement in terms of health and autonomy within the household because women were closer to caught up with men in those standards compared to the political representation of women. Hence, although remaining the most underdeveloped dimension of the HGEI levels, political power is the dimension with the highest growth, which pushed the HGEI up. Socioeconomic status is the second driver of the improvement of gender equality. However, its contributions are rather minimal compared to political power, although there are still critical gaps to narrow in schooling and workforce participation; this reveals that the index is historically stagnated.

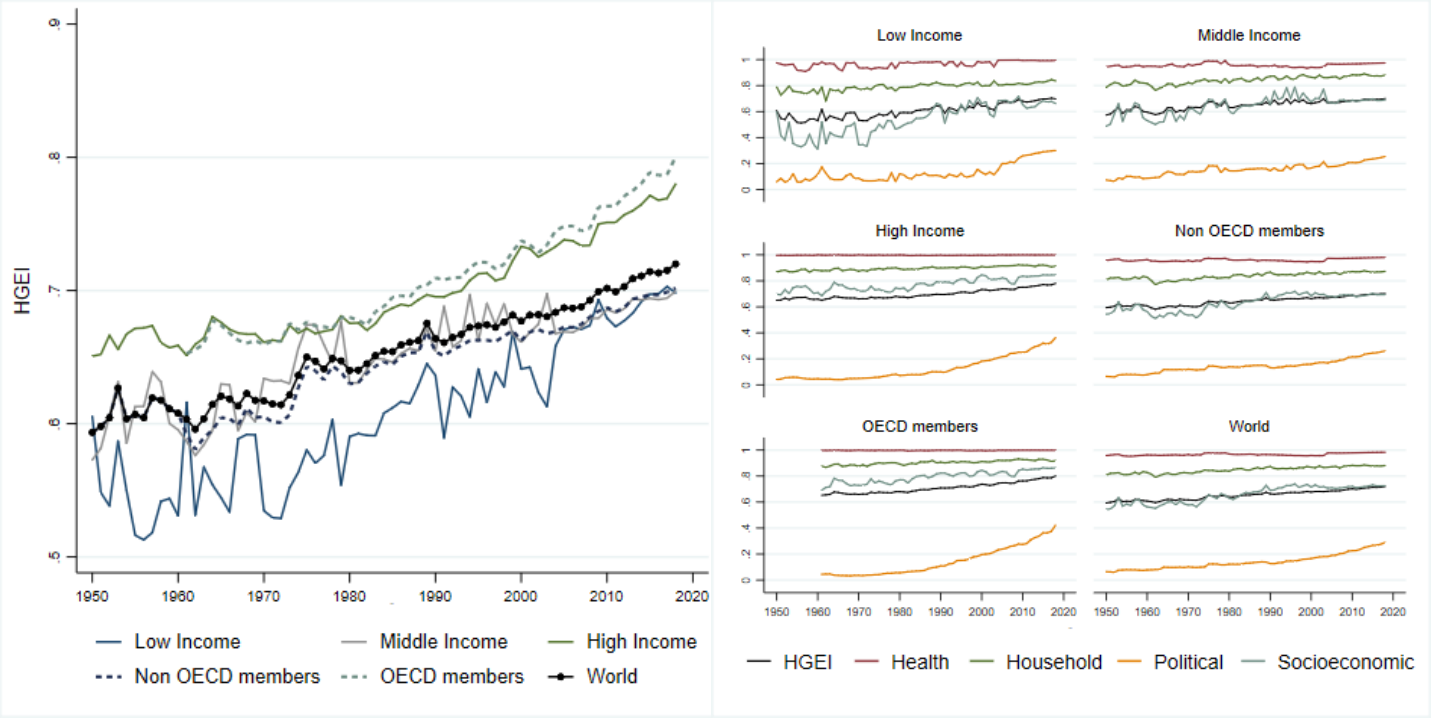
Lastly, as shown in panel "d", there is a positive association between historical gender equality and economic growth, this applies to some regions to larger extents than others. While in North America economic growth has been obtained accompanied by improvements in gender equality; Sub-Saharan Africa has managed to improve the position of women in society without significant gains in income per capita. Appendix C extends this insight by decomposing the analysis per dimension.

Similar reasoning of panels "a"-"d" can be applied to Figure 5, which characterizes countries depending on their development stage by two criteria. First, according to the income level, a country is considered to be low (high) income if its per capita income in a year is located within the lower (upper) quartile of the world's income distribution during that year; this allows countries to move between income categories over time depending on their relative position in the global income distribution. Second, the OECD classification considers countries part of that group from the moment they join the organization. In short, the historical descriptive evidence shows that gender equality tends to move along with the development stage of countries.

Figure 5: HGEI descriptive statistics by development stage, 1950-2018*

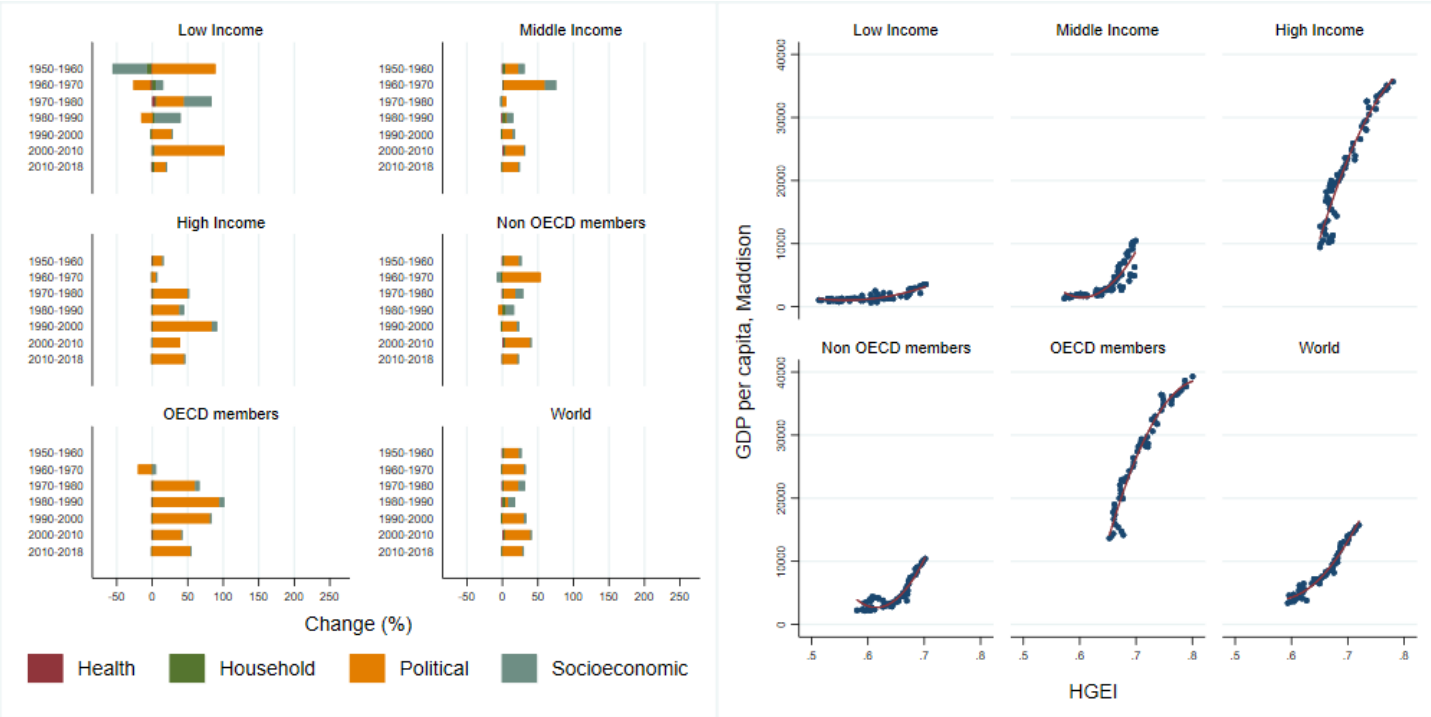
a. HGEI performance per development stage

b. HGEI dimensions by development stage



c. Drivers of HGEI growth by development stage

d. HGEI and economic development by development stage



Source: author's calculations

* Countries are identified as low (high) income if their average income in a year was located within the lower (upper) quartile of the world's income distribution during that year. Similarly, they are considered part of the OECD only after the officially join the organization.

4 Inferential results

To disentangle the effects of gender equality ($x_{i,t}$) on economic development ($y_{i,t}$), as in the following baseline specification,

$$\ln(y_{i,t}) = \alpha_0 + \alpha_1 x_{i,t} + \beta C_{i,t} + \varepsilon_{i,t} \quad (11)$$

The HGEI and the addition of its underlying dimensions were modified by transforming them into a 0-100 scale to ease the coefficients' interpretation. The results were obtained using data from the 1961-2018 period, the full coverage of the updated HGEI was not entirely exploded since the record for the majority of the control variables becomes available after 1960. This implies that, for the estimations, $x_{i,t}$ fulfills either:

$$x_{i,t} = \left(HGEI_{i,t}\right) \times 100,\ t \in [\,1961, 2018\,] \quad (12)$$

$$x_{i,t} = \left(Health_{i,t} + Household_{i,t} + Political_{i,t} + Socioeconomic_{i,t}\right) \times 100,\ t \in [\,1961, 2018\,] \quad (13)$$

Additionally, each regression was run using the full longitudinal sample and decomposing it by the development stage of each country: low, middle, and high income. Instead of using arbitrary divisions, like absolute poverty lines fixed over time, countries were classified in the low (high) income category if their per capita income in a year was located within the lower (upper) quartile of the world's income distribution during that year. This division enables countries to move between development stages depending on their yearly relative position in the global economy. Appendix D recaps the classification of the income categories.

As a benchmark for more sophisticated methods, a pooled OLS of equation (11) could be problematic because it provides unreliable inefficient estimates, instead, a random-effects (RE) model is preferred for panel data structures (Gujarati & Porter, 2009). Table 7 reports the results from this estimation.

Essentially, the RE evidence suggests that gender equality affects economic development differently depending on the income level of the countries. There is an absent effect in low and middle-income countries. Low-income countries seem to only perceive gains in income due to improvements in the autonomy within the household for women; whereas middle-income economies also benefit from improvements in the health sub-index, but their development deteriorates when increasing the gender equality in the socio-economic aspect.

Table 7: Effects of gender equality on economic development, random effects estimation
Dependent variable: ln of GDP per capita

Variable	Income classification							
	Full sample		Low income		Middle income		High income	
HGEI	-0.002**		-0.001		-0.002		0.012***	
	(0.001)		(0.002)		(0.001)		(0.001)	
Sub-indices								
Health		0.012**		-0.007		0.025***		0.015***
		(0.005)		(0.009)		(0.006)		(0.005)
Household		0.024***		0.006***		0.006***		0.011***
		(0.002)		(0.002)		(0.002)		(0.002)
Political		0.000		-0.001		-0.000		0.003***
		(0.000)		(0.001)		(0.000)		(0.000)
Socioeconomic		-0.007***		-0.000		-0.003***		0.003***
		(0.001)		(0.001)		(0.001)		(0.001)
Observations	5,384	5,384	1,161	1,161	2,279	2,279	1,944	1,944
Countries	122	122	44	44	76	76	57	57
Hausman test[a] (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Countries were identified as low (high) income if their average income in a year was located within the lower (upper) quartile of the world's income distribution during that year.
[a] Null hypothesis: time-invariant country fixed effects that determine development are correlated with the gender equality measures.

A positive effect is only found in high-income economies for the HGEI and all its dimensions in Table 7. When pooling all the samples, the results unexpectedly do not coincide with any of the decomposed income categories.

The results from the RE estimation should be, however, interpreted conservatively because, as argued above in the identification strategy sub-section, they do not control for three sources of endogeneity. First, there are country time-invariant idiosyncratic characteristics, or "fixed effects", that might condition both gender equality and economic development. Indeed, the evidence from the Hausman fixed effects test, shown at the bottom of Table 7, supports the hypothesis that the RE estimates are biased in this regard.

Second, my analysis considers the historical effects of gender equality on economic development. However, as covered in the literature review, scholars have theorized that economic development could also explain changes in gender gaps. This possibility of a bidirectional relationship between both variables could make the RE estimates biased due to reverse causality.

A third possible bias of the RE outcomes consists of the possibility of economic development and gender equality standards being explained by specific junctures. In

my panel structure, this would imply global deviations from the trend of the two covariates after a particular year.

To rule out the presence of any of those endogeneity issues, the baseline specification is re-computed by implementing the Anderson-Hsiao (1981) GMM estimator, as suggested in equation (9) in the Empirical framework. Table 8 presents the output of this estimation.

The GMM effect of gender equality as a whole on economic development, measured by the HGEI coefficients, differs from the RE estimates in the sign of the relationship, and also in the magnitude of it. Particularly, RE understates the effect of gender equality in high-income countries and does the opposite in low-income ones. The discrepancies between both methods, in both sign and magnitude, increase in the multidimensional specifications without any specific pattern. Besides, the GMM estimation uses a lower number of observations, this happens because the panel is unbalanced -not all countries have measurements in all the years- and the mechanism computes the first difference of some variables.

The preference of the Anderson Hsiao (1981) GMM estimates over the RE ones depends on the validity of the instruments. A valid instrument fulfills being exogenous and relevant. The first condition occurs given the assumptions of the model. To examine the second validity condition, Table 8 includes the simplified first stage of the estimation. Simplified meaning that, to obtain every coefficient in the multidimensional specifications, it is necessary to estimate a regression of the first difference of each dimension on its lagged value, the lagged values of the remaining dimensions, and the first difference of the set of controls; only the coefficients for the pair-wise dimensions are reported in the first stage tabulation.

Overall, the evidence from the first stage supports the condition of relevant instruments. The prevailing negative sign is directly related to the convergence of gender equality over time; as already depicted in Figure 3, countries with higher departure levels of gender equality tend to improve slower those standards. More importantly, the instruments are consistently significant, and therefore relevant in all the specifications in Table 8.

Table 8: Effects of gender equality on economic development, GMM estimation

Variable	Second stage. Dependent variable: ln of GDP per capita							
	Income classification							
	Full sample		Low income		Middle income		High income	
HGEI	-0.007**		-0.012**		0.003		0.026***	
	(0.003)		(0.005)		(0.003)		(0.008)	
Sub-indices								
Health		0.022***		0.014		0.032***		0.050**
		(0.006)		(0.015)		(0.009)		(0.020)
Household		-0.006***		-0.004**		-0.003**		0.003
		(0.001)		(0.002)		(0.001)		(0.003)
Political		0.005**		-0.002		0.005*		0.020
		(0.003)		(0.006)		(0.002)		(0.012)
Socioeconomic		-0.002***		-0.003**		-0.001		0.006
		(0.001)		(0.002)		(0.001)		(0.004)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Included controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,145	5,145	1,117	1,117	2,170	2,170	1,858	1,858
Countries	122	122	44	44	72	72	57	57
Simplified[b] first stage. Dependent variable(s): HGEI or sub-indices								
	Full sample		Low income		Middle income		High income	
HGEI	-0.039***		-0.056***		-0.078***		-0.024***	
	(0.006)		(0.014)		(0.012)		(0.006)	
Sub-indices								
Health		-0.100***		-0.148**		-0.091***		-0.134***
		(0.028)		(0.074)		(0.028)		(0.043)
Household		-0.223***		-0.268***		-0.391***		-0.440***
		(0.016)		(0.032)		(0.027)		(0.036)
Political		-0.022***		-0.024***		-0.044***		-0.019***
		(0.005)		(0.009)		(0.014)		(0.007)
Socioeconomic		-0.137***		-0.187***		-0.123***		-0.116***
		(0.015)		(0.029)		(0.018)		(0.016)
Observations	5,145	5,145	1,117	1,117	2,170	2,170	1,858	1,858
Countries	122	122	44	44	72	72	57	57

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Countries were identified as low (high) income if their average income in a year was located within the lower (upper) quartile of the world's income distribution during that year.

The data used covered the 1961-2018 period. All the regressions were run based on the Anderson and Hsiao (1981) GMM specification, which implements a combination of time-invariant country fixed effects, and instruments each potentially endogenous variable by its lagged value. Besides, each regression controls for a lagged dependent variable, population growth, human capital, investment (%GDP), government expenditure (%GDP), trade openness (%GDP), life expectancy, annual inflation rate, democracy level, and yearly fixed effects.

[b] The first stage is simplified in the sense that, for the multidimensional estimations, the coefficients were obtained from different regressions.

4.1 Contextualization

Relying on the GMM output, my empirical findings suggest that there is not a unique generalizable effect of gender equality on economic development, rather it depends on the development stage of each country and the role of the dimensions. These results are consistent with the findings of Dollar and Gatti (1999) who found a non-linear relationship that becomes notably increasing and positive in higher stages of development. Furthermore, my findings partially fit with the quantitative results of Eastin and Prakash (2013); who characterize the advancement of gender equality in three female empowerment waves. I adapt my results to their qualitative explanations to place in context the behavior of my estimates.

As seen in Figure 5, after falling behind during the second half of the 20th century in terms of gender equality, in the new century low-income countries have managed to catch up with the standards of middle-income countries. Despite these improvements, low-income economies have perceived scarce economic success after 1950. Eastin and Prakash (2013) defend the hypothesis that, during early development stages, the technological progress from germinal industrialization might foster an increase in the likelihood of female work that translates into a further improvement in the share of family income, education of the daughters, institutional representation, and overall an initial wave of female empowerment in the development path of countries.

In Table 8, the negative significant coefficient of the HGEI for low-income countries depicts that those initial achievements in the terrain of gender equality do not turn into economic development; in fact, they harm it. It does not take long until micro and macro patriarchal institutions intervene, they seek the re-instauration of "traditional" values in light of the first empowerment wave (Eastin & Prakash, 2013). These interventions could dilute the potential benefits of further gender equality on economic development, which explains the insignificant HGEI coefficient for middle-income economies (Eastin & Prakash, 2013).

At the micro-level, the negative association among gender equality and development could reveal inefficiencies in the labor markets since women start to compete against men for scarce job positions, which could evolve into diverging income trajectories between genders. At the macro-level, the achievements of the first empowerment wave might threaten patriarchal institutions, their backlash could reconfigure the society with counterproductive allocations (Eastin & Prakash, 2013). For low and middle-income economies, the negative coefficient sign of the socioeconomic and autonomy within the household sub-indices fit into this narrative.

When combining the three development categories into one full sample, the HGEI coefficient is slightly negative and gravitates between the estimates found for the low and middle-income economies. This is an expected behavior considering that around 64 percent of the observations belong to these two development groups. Similarly, the results obtained for the gender equality dimensions can be understood as a linear combination of the coefficients estimated for the sub-indices in those two categories.

It is important to remark that my finds should not be, by any means, used in favor of actions promoting discrimination against women. The negative HGEI coefficient found for low-income economies and the insignificant one for middle-income countries do not justify interventions aiming to deteriorate the societal position of women as a channel to achieve economic development. Contrarily, my estimates should be taken as informative of the fact that patriarchal institutions might seek to reverse advances in gender equality, as noted by Eastin and Prakash (2013). Therefore, future policies designed to close gender gaps -one of the United Nations' sustainable development goals- in these development stages must be coupled with corrective strategies that anticipate the backlash coming from those reactionary patriarchal forces.

After surpassing the development threshold and becoming high-income countries, the relationship between gender equality and economic development becomes significant and positive. As shown in Table 8, everything else being constant, closing the gender gap by 1% could increase income per capita by around 2.6% in these countries. Eastin and Prakash (2013) adduce that, at the micro-level, this might be the result of higher returns to female human capital, which was systematically accumulated by younger women during the second empowerment wave and becomes "profitable" until the third wave. At the macro level, this reflects that the patriarchal arguments might have lost ground, letting new social norms and institutions reallocate social values in favor of economic progress along with an agenda for gender equality (Eastin & Prakash, 2013).

In the multidimensional model for high-income countries, only the health dimension exhibits a significant positive effect on economic development, whilst the effect of the rest is statistically equal to zero. Interestingly, as shown in Figure 5, high-income countries have leaded gender equality, within these economies health historically performs as the most equal dimension. In 1950, on average[2], the health gender gap in high-income economies was only 0.4 percent; by 2018, the latest year in my sample, the gap had almost closed, it diminished to 0.16. This sustained gender-equal behavior makes it unreasonable to expect a drastic narrowing of this health gap in the upcoming years, rather it will probably converge slowly towards zero in a longer horizon.

[2] This corresponds to the average of all high-income countries weighted by their annual population.

Based on my multidimensional estimates in the higher development stage, one could argue that the contribution of gender equality to economic growth has almost reached its maximum considering, first, that economic development does not seem to be obtained through independent improvements in the female socio-economic, political, and household autonomy status; second, that there is little scope for accelerated future economic development by narrowing the health gender gap. Oppositely, the positive and significant coefficient found for the HGEI in the unidimensional regression is more optimistic from a prospective viewpoint for those countries.

Although apparently contrasting, the unidimensional and multidimensional findings in high-income countries do conciliate. My evidence suggests that, for these economies, gender equality enhances per capita income in two scenarios. One possibility is closing the health gender gap, however, as commented above, this might not be realistically feasible in the near future. The other scenario consists of synchronically improving the socio-economic, political, and household autonomy dimensions. This comes from the fact that, in my estimations, their individual contributions do not enter as significant in the multidimensional specification; but, when adding them up in the unidimensional regression, the HGEI becomes significant for economic development.

In sum, based on my findings, even if the discrimination against women is measurably lower in high-income countries, closing the gender gaps there in the future has the potential to improve economic development. The gains probably would not come from improving female health standards, as they have almost caught up to male ones, but from jointly enhancing the role of women in the rest of the dimensions, which are lagging, and therefore there is still a broader scope to improve them. To exemplify, by 2018, on average[3], high-income economies reported a gender gap of around 64% in political representation in my sample; 15% in socioeconomic status; and 9% in the autonomy within the household.

[3] This corresponds to the average of all high-income countries weighted by their annual population.

5 Conclusion

In this project, I aimed to implement a cliometric approach to analyze the historical effects of gender equality on economic development to a macroeconomic extent. For this sake, my research followed two main objectives. First, to obtain a multidimensional longitudinal measure of gender equality that covers a big sample of countries during a comprehensive but recent historical period. Second, to take advantage of such measure in an empirical strategy that disentangles the effects of gender equality and its different dimensions on economic development.

There are several available measures of gender (in)equality computed by scholars and policy circles, after revisiting them and evaluating their strengths, in the end, I strategically selected the Historical Gender-Equality Index (HGEI) created by Dilli, Carmichael and Rijpma (2019) due to two convenient reasons for my research. In the first place, it exhibits a multidimensional decomposable feature that allows to compile a broader picture of gender equality in a single indicator or to disaggregate it by four components that capture the living standards and wellbeing of women relative to men; namely, health, autonomy within the household, political representation, and socioeconomic status. In the second place, compared to other indices, the HGEI presented the broadest coverage over time and space, as it documents the stage of gender equality in 130 countries during the 1950-2003 period.

Since I expected my findings to reveal updated insights about gender equality and its effects on economic development, I modified the original HGEI by Dilli, Carmichael and Rijpma (2019) in two ways. Firstly, I collected and standardized information from several reliable primary sources to update its four sub-indices until 2018. Secondly, I improved the accuracy of the imputations. To avoid patchy data, Dilli, Carmichael and Rijpma (2019) used the software "Amelia II" to predict the missing values in the sub-indices. This program developed by Honaker, King and Blackwell (2011) implements imputation techniques that take advantage of the historical behavior of each series and additional auxiliary variables. I managed to compute more precise imputations for the full 1950-2018 period considering that I endowed Amelia II with an enhanced set of auxiliary variables and wider historical data coverage.

As a result of combining both the unimputed and imputed values, I computed the updated HGEI. My final dataset is an unbalanced panel of 130 countries, the majority of them are tracked from 1950 until 2018. To the best of my knowledge, at the time of this publication, there is no other data source with such a comprehensive historical

assessment of gender (in)equality across countries. I made the updated HGEI database available in the Online Appendix.

To a descriptive extent, some conclusions could be extracted from the updated HGEI itself. At a national level, when historically ranking the countries according to the index score, the upper tail of the distribution was dominated by Eastern European countries before the disintegration of the Soviet bloc, and then by Western European countries; particularly, Sweden, Finland, Norway, Denmark, and the Netherlands steadily occupy the first positions in the lists. I found, however, that countries with high initial levels of gender equality tend to improve slower those standards, this might be related to the possibility of convergence, meaning lower-ranked countries could be eventually catching up with the leaders. On the other extreme of the distribution, the lower tail has historically been occupied by countries in the Middle East and North Africa region; especially, Niger, Yemen, Afghanistan, Pakistan, and Jordan.

At an aggregate level, my descriptive findings show that in all the world regions and development categories the list of the updated HGEI sub-indices from most to least gender-equal is: health, autonomy within the household, socioeconomic power, and political representation. Ideally, this order will be taken into consideration to set priorities for future policies within the gender-egalitarian agenda. Indeed, my historical evidence suggests that the improvements in gender equality, measured by the growth of the updated HGEI, have mainly been explained by advances in the political representation of women, which is expectable considering that it was the dimension with the highest potential of progress, as it is the most unequal, and it is the only one that could be intervened by fixing gender quotas.

The female socioeconomic status, as the second most backward dimension, on the other hand, has also had ample ground for improvement during the observed period, however, due to its relatively historical stagnation, it has barely contributed to the improvement of gender equality. This should also motivate social institutions to question why has the socioeconomic female status been neglected and how to change that.

The updated HGEI was suitable enough to follow my second research objective, to analyze the relationship between gender equality and economic development. Previous literature on the topic has theorized that gender equality may affect economic progress through several mechanisms, but also that higher levels of per capita income could translate into improvements in the societal position of women.

To answer my research questions, my framework considers the direction from gender equality to economic development. Nevertheless, aware of the theoretical possibility of reverse causality, I take advantage of the longitudinal structure of my data to implement a Generalized Method of Moments (GMM) estimation, particularly the

Anderson and Hsiao (1981) one. This empirical strategy also controls for time-invariant country fixed effects, these are country idiosyncratic characteristics that determine economic development, but could be also related to the stage of gender equality in each country; indeed, the results from a Hausman test show that not correcting for them could bias the estimates. Within the GMM model, I also include year-fixed effects which control the possibility of per capita income being affected by particular transitory junctures like economic crises or peculiar growth periods.

My inferential findings, therefore, emerge from an empirical framework that aimed to rule out critical endogeneity hazards: omitted variable bias, country time-invariant fixed effects, year fixed effects, and, most importantly, reverse causality. Besides, I run several regressions to isolate the effect of gender equality on income per capita depending on the development stage of each economy, but also to exploit the multidimensional and decomposable features of the HGEI.

Consistent with the conclusions from other scholars (Dollar & Gatti, 1999; Eastin & Prakash, 2013) my inferential results show that there is not a unique and generalizable effect of gender equality on economic development, rather it depends on the development stage of countries. Particularly, based on my estimates, the effect is negative in low-income countries, insignificant in middle-income countries, and positive in high-income countries. I subscribed to the narrative of Eastin and Prakash (2013) to provide a qualitative interpretation of my findings.

They proposed that, for earlier development stages, initial gender equality advances could harm economic development because those achievements might threaten the "traditional" values of micro and macro patriarchal institutions to the extent that they may intervene (Eastin & Prakash, 2013). These institutional interventions could evolve into socially inefficient and unproductive allocations, explaining the negative sign for least developed countries; and dilute the potential benefits of further gender equality on economic progress, explaining the insignificant HGEI coefficient found for middle-income economies.

My findings, specifically the negative and insignificant coefficients, should not promote damaging the social position of women as a strategy to accomplish economic development. Instead, as a practical implication for low and middle-income countries, I suggest that future policy interventions designed to narrow gender gaps shall be accompanied by corrective strategies that anticipate the backlash coming from those reactionary patriarchal forces.

The positive and significant sign found for high-income countries depicts that, in higher development stages, patriarchal structures that embraced female discrimination are substituted by new institutions that embrace the reallocation of social values toward

gender equality. When patriarchal arguments from the previous stages lose ground, the empowerment of women flourishes along with economic progress (Eastin & Prakash, 2013).

When comparing the unidimensional and multidimensional results for higher developed economies, a practical implication was concluded: future contributions of gender equality to economic progress in these countries might not depend on enhancing female health standards, as they have almost caught up with that of men, but on synchronically closing the gender gaps in political representation, the socioeconomic status, and the autonomy within the household.

In consideration of my work and its conclusions, my contribution to the gender analyses within the development literature is twofold. First, I managed to update and improve the HGEI, to my knowledge, the measure of gender (in)equality with the most comprehensive coverage over time and space. Second, I implemented the first approximation of the effects of gender equality on economic development that uses the updated HGEI; my empirical strategy aimed to deliver reliable results, as it ruled out several potential endogeneity biases. My research is, however, subject of improvement in many regards.

Regarding the indicator, future extensions of the HGEI could pursue using better proxies for its dimensions, finding primary data sources with lower missingness to diminish the reliance on imputation techniques, and expanding the index by increasing the coverage in more countries and years before 1950. Concerning the estimation technique, future research can consider new approaches, for instance, implementing other instrumental variables, characterizing the relationship between the HGEI and demographic transitions, or exploring shocks that affected gender equality in particular regions and periods.

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Appendix A

Comparison of composite indicators on Gender Equality					
	Index				
Criteria	Gender Development Index* (GDI)	Gender Empowerment Measure (GEM)	Gender Equity Index (GEI)	Gender Gap Index (GGI)	Standardized Index of Gender Equality (SIGE)
Source of the last release	UNDP (2020)	UNDP (2009)	Social Watch (2012)	World Economic Forum (2021)	Dijkstra (2002)
Coverage					
Countries	167	106	156	107	115
Years (available releases)	1995-2019	1995-2009	2005-2012	2005-2021	1994
Frequency	Unbalanced	Unbalanced	Unbalanced	Balanced	Unique release
Dimensions					
a. Health	Life expectancy ratio			Life expectancy ratio Sex ratio at birth	Life expectancy ratio
b. Autonomy within the household					
c. Empowerment		Women in parliament Female legislators, senior officials, and managers	Women in parliament Female legislators, senior officials, and managers Women at the ministerial level	Women in parliament Female legislators, senior officials, and managers Women at the ministerial level Females head of state	Women in parliament Female legislators, senior officials, and managers

Comparison of composite indicators on Gender Equality

Criteria	Index				
	Gender Development Index* (GDI)	Gender Empowerment Measure (GEM)	Gender Equity Index (GEI)	Gender Gap Index (GGI)	Standardized Index of Gender Equality (SIGE)
d. Socioeconomic status					
Schooling	Literacy ratio School gross enrollment ratio		Literacy ratio Primary, secondary, and tertiary net enrollment ratio	Literacy ratio Primary, secondary, and tertiary net enrollment ratio	
Labor market	Estimated earned income ratio	Estimated earned income ratio Female professional and technical workers	Estimated earned income ratio Female professional and technical workers Women in non-agricultural paid employment	Estimated earned income ratio Female professional and technical workers Labor force participation ratio Wage equality	Female professional and technical workers Labor force participation ratio
Number of single indicators	4	4	10	14	4
Critiques	Should not be interpreted as independent from the HDI A problematic earned income variable	Poor indicator availability Small country sample	Omits the health dimension Based on shaky data	Focuses on developed countries Complex weighting procedure and interpretation	Problems of comparability over time

*In 2010, the UNDP replaced the GDI with the Gender Inequality Index (GII).

Based on Jütting, Morrisson, Dayton-Johnson and Drechsler (2008, p.76), and the critiques from Klasen & Schüler (2011).

Appendix B

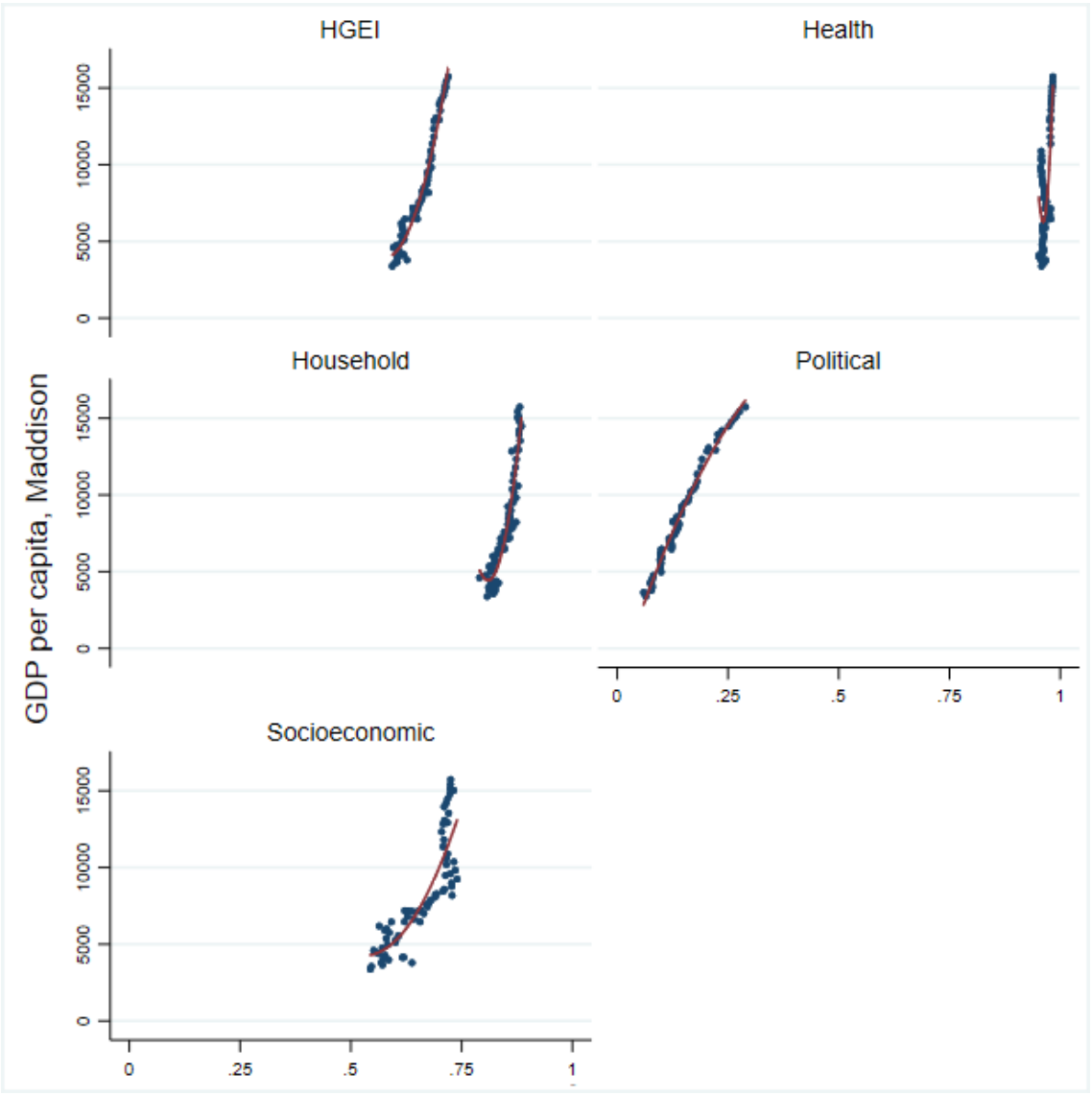
Comparison of the imputed values' summary statistics between the updated and original HGEI for the 1950-2003 period

Indicator	Data source								Difference of means
	Updated				Original				
	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	
a. Health									
Life expectancy	0.800	1.000	0.969	0.030	0.800	1.000	0.969	0.030	0.000
Sex ratio	0.829	1.000	0.996	0.018	0.829	1.000	0.996	0.018	0.000
Total	0.882	1.000	0.986	0.016	0.881	1.000	0.988	0.016	-0.001
b. Autonomy within the household	0.607	0.981	0.838	0.054	0.607	0.981	0.840	0.054	-0.002
c. Political power	0.000	0.953	0.104	0.109	0.000	0.953	0.094	0.107	0.011
d. Socioeconomic Status									
Schooling	0.025	1.000	0.702	0.225	0.025	1.000	0.712	0.214	-0.010
Labor force participation	0.014	1.000	0.560	0.215	0.022	1.000	0.551	0.214	0.008
Total	0.083	1.000	0.630	0.175	0.096	1.000	0.630	0.170	0.000
Historical Gender Equality Index (HGEI)	0.429	0.919	0.640	0.071	0.442	0.926	0.638	0.071	0.002

Source: author's calculations

Appendix C

Worldwide relationship between HGEI dimensions and economic development, 1950-2018



Source: author's calculations

Appendix D

Decadal distribution of the income categories

Decade	Countries in each income category (%)			Real per capita GDP (2011 U.S. dollars) summary statistics			
	Low	Middle	High	Min.	Max.	Mean	Std. dev.
1950s	17	54	29	489	52,920	4,819	7,343
1960s	11	61	29	564	58,010	6,141	7,808
1970s	17	51	33	713	68,407	8,077	9,074
1980s	20	44	35	843	45,860	8,731	8,645
1990s	28	35	37	378	51,129	10,279	10,507
2000s	26	35	39	404	115,283	14,846	16,072
2010s (until 2018)	31	28	41	561	156,299	18,676	21,020

Source: author's calculations

Countries were identified as low (high) income if their average income in a year was located within the lower (upper) quartile of the world's income distribution during that year.