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24 August 2015

Online at https://mpra.ub.uni-muenchen.de/66295/
MPRA Paper No. 66295, posted 27 Aug 2015 06:57 UTC

Intelligence and gender (in)equality: empirical evidence from developing countries

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Final version working paper

Cite as: Salahodjaev, R. & Azam, S. (2015). Intelligence and gender (in)equality: Empirical evidence from developing countries, *Intelligence, 52*, 97-103, http://dx.doi.org/10.1016/j.intell.2015.08.002.

Abstract: This paper makes an attempt to explore whether intelligence of nations is related to gender inequality, measured by Social Institutions and Gender Index (SIGI), in developing countries. Related literature robustly links intelligence to economic development, poverty, quality of institutions and informal economic activity. Controlling for conventional antecedents of gender inequality (i.e. religion, political regime, legal origins and trade openness), this paper finds that, on average, a 10-point increase in national IQ scores in the developing world is associated with an 8.2 point reduction in SIGI, ceteris paribus. To test the robustness of our findings we apply instrumental variables (IV) and robust regression methods. We also test whether our results are sensitive to the choice of control variables and heterogeneity of nations in our sample. The negative association of intelligence with gender inequality remains statistically significant and intact in all cases.

Keywords: intelligence; IQ; gender equality; cross-country; SIGI; developing countries

1. **Introduction**

Promoting gender equality and women's empowerment is at the core of the international development agenda. Naturally, gender inequality has important implications for society as it has been shown to hinder overall development and increase deprivation (World Bank, 2001). In particular, it has been connected to economic growth (Esteve-Volart, 2000), investment in infrastructure (Chattopadhya & Duflo, 2001) and corruption (Dollar et al., 2001). Therefore, identifying the driving forces of gender equity has been an important subject of research in social sciences, especially over the last decade.

While a growing literature reports that religion, institutions and democracy 'make a significant impact on gender inequity' (Rao & Kelleher, 2003 p. 142), we investigate a variable that has not received the recognition we think it deserves in the analysis of international differences in gender inequality, namely intelligence.

The significance of intelligence (cognitive skills) has become broadly acknowledged in empirical literature over the last decade (Lynn & Vanhanen, 2012a). For example, intelligence has a significant association with long-run economic growth (Ram, 2007), earnings and income inequality (Kanazawa, 2009). Yet, it is conceivable that intelligence leads to other benefits to the public which are not captured by monetary indicators such as GDP per capita and wages. One possible noteworthy illustration of the positive externalities of intelligence may be an enhanced role of women in society.

To what extent does intelligence contribute to gender equality? In this study we hypothesize that the benefit of intelligence builds up either through the quality of institutions, or through civic participation among citizens. Indeed, related literature demonstrates that intelligence is an important determinant of institutional arrangements (Kanyama, 2014; Salahodjaev, 2015a). For example, in early empirical articles intelligence, measured by the Army General Classification Test, is positively linked with the rule of law at the US state level (Davenport & Remmers, 1950). More recently, Potrafke (2012), using data from 125 countries, documents that intelligence, measured by national IQs, has a negative relationship with the corruption perceptions index. In this vein, cognitive abilities are positively correlated with approval for progressive reforms and negatively correlated with radical positions (Inglehart, 1997).

Further, particular causal explanations connecting the quality of institutions to gender equality are a cognitive effect and an ethical effect, which are in turn determined by the intelligence of nations that 'can process complex information and actively participate in politics' (Simpson, 1997 p. 157). Certainly, if traditional patriarchal societies ignored the role of women in the community, then intelligence is a potential determinant of modern values as it nurtures 'a habit of critical thinking, questioning religious dogmas and other sources of traditional authority' (Meisenberg, 2004 p. 139). While Solon (2014) highlights that intelligent individuals are more likely to provide greater freedom to less represented groups of society, there is also evidence that intelligence leads to liberalism, prosociality (Solon, 2014) and generosity (Millet & Dewitte, 2007). Therefore, a positive link between intelligence and pro-gender institutions is predictable as intelligence 'broadens man's outlook, enables him to understand the need for norms of tolerance, restrains him from adhering to extremist doctrines, and increases his capacity to make rational electoral choices' (Lipset, 1960 p. 54).

Moreover, gender inequality is also negatively associated with political participation, an aspect of human behavior that is captured by intelligence (e.g. Meisenberg & Lynn, 2011). For example, in a study of 12,000 respondents from the High School and Beyond Survey, Dee (2004) documents that educational attainment is an important antecedent of an efficiently functioning democracy. In particular, when schooling increases by one year, political participation increases by

6.8%. Dee (2004) also shows that education has a positive impact on other measures of civic behavior.

Milligan et al. (2004) finds that education has a positive association with political participation. Their results show that educated individuals are more likely to vote, follow political news and possess more information on candidates and campaigns since they recognize the public needs which will influence their vote. In a study of participants in the 1970 British Cohort Study, Deary et al. (2008) detect a positive relationship between childhood intelligence and the probability of voting in elections. Further, the study reports that individuals with higher scores in the British Ability Scales test are more likely to attend demonstrations and sign petitions. In this line, similar studies find that assessment tests scores are negatively correlated with conservatism – another determinant of gender inequality (Cohen, 2004) on an individual and country level (Stankov, 2009). Thus, we anticipate that intelligence has a negative association with gender inequality as 'democratic societies usually have more women in parliament than under democratic societies' (Inglehart et al., 2002 p. 232).

The hypothesized intelligence-gender equality nexus is tested on a sample of 107 nations. The measure of inequality is the Social Institutions and Gender Index (SIGI) for 2014. The results indicate that a 10-point increase in national IQ scores is associated with an 8.2 point reduction in gender inequality (SIGI).

This paper is structured as follows: Section 2 presents data and methodology, Section 3 discusses the main results and Section 4 concludes the paper.

2. **Data and methods**

Dependent variable

Whereas many gender-related indices such as the Gender Equity Index (Social Watch Report, 2005), Gender Inequality Index (GII Report, UNDP, 2010), Global Gender Gap Index (Lopez-Claros & Zahidi, 2005) and others are generally considered to be outcome-based indicators that disclose the after-effects of already-established institutional environments (gender-related gaps in education, health, employment, and political participation), the Social Institutions and Gender Index (SIGI) mainly targets the origins of gender inequalities and reflects the state of affairs in both formal and informal institutions (societal norms, values, traditions, customs, cultural peculiarities etc.) that shape and bring about gender-related inequality issues in different countries (Neumayer & De Soysa, 2007; Branisa et al., 2014). As Klasen & Schüler (2011 p. 8) put it 'the innovation of SIGI is that it shows how social institutions affect gender inequality; thus, it focuses not on gender outcomes, but on institutions that affect such outcomes'. In this sense the SIGI captures those aspects of gender inequality that go beyond related rights and liberties, and rest upon institutional causes of the issue.

The SIGI consists of such sub-indices as Family code, Civil liberties, Physical integrity, Son preference, and Ownership rights which are calculated based on different social indicators taken from the Organization for Economic Cooperation and Development's (OECD) Gender, Institutions and Development Database. It 'combines them into a multidimensional index of women's deprivation caused by gendered social institutions … and empirical results confirm that the SIGI complements other gender-related indices' (Branisa et al., 2014 p. 29).

This index has been used in different contexts. For instance, Branisa et al. (2013) empirically proves that contemporary issues surrounding gendered development outcomes need to consider inequalities in social institutions as a separate constraint. They demonstrate how institutions fostering gender equality are associated with female education, child mortality, fertility, and corruption. On the other hand, there is evidence that these institutions are also associated with women's labor market participation (e.g. Jüttig et al., 2010). Yet, some other studies using SIGI show that the economic and social aspects of globalization strengthen institutions fostering gender equality (e.g. Potrafke & Ursprung, 2012).

Independent variable

Intelligence is the main variable of interest in this study. As a proxy for intelligence we rely on national IQ data from Lynn & Vanhanen (2012b). This dataset, a revised edition of Lynn & Vanhanen (2002), contains national IQs for the majority of nations and has been widely used in empirical studies (see e.g. Voracek, 2004; Salahodjaev, 2015a; Salahodjaev, 2015b; Burhan et al., 2015). It represents a compilation of numerous average national IQ tests observed over the past 100 years or longer. For those geopolitical regions with missing administered intelligence tests 'estimated IQs were obtained from the measured IQs of neighboring countries with culturally and racially similar populations' (Lynn & Meisenberg, 2010 p. 354). Overall, after discarding possible missing observations for other control variables IQ scores range from 60.1 in Malawi to 105.8 in China.

Control variables

In order to address potential omitted variable bias, we use a set of control variables. First, we control for the percentage share of Muslims among the population. Related studies find that cross-country differences in gender inequality are substantially explained by the established heritage, beliefs and norms related to marriage, proprietorship and paternity (e.g. Morrisson & Jütting, 2005).

In addition to religion, political studies suggest that democratic regime and political orientation of the ruling government are also linked to enforcement of gender equality laws. We use democracy index, measured as average of political rights and civil liberties, in our empirical model because it is widely conjectured that democratic societies pay greater attention to gender balance compared to authoritarian regimes (Norris & Inglehart, 2001; Beer, 2009). Neumayer & De Soysa (2007 p. 1521) argue that "[s]ince women represent a slight majority in most country's electorate, one would expect that in fully democratic countries women enjoy no worse economic rights than men". Similarly, related studies establish that left-leaning parties put greater value on gender equality (Dahlerup, 2005). For example, gender movements in Eastern Europe were successful to initiate legislative and institutional reforms under the rule of leftist parties (Avdeeva, 2009). As a measure of political orientation we use a dichotomous variable for left-leaning governments.

We add dummy variables for Napoleonic civil law and Communist common law from La Porta et al. (1999). Indeed, since the seminal works of Acemoglu et al. (2001) and La Porta et al. (2009) ample cross-country studies document the impact of legal origins on institutions, corruption, financial development and gender inequality (Albouy, 2012; La Porta et al., 2008; Jayachandran, 2015; Salahodjaev, 2015c). For instance Potrafke & Ursprung (2012) find that gender institutions are stronger in nations with communist common laws as compared to nations with English common law.

Finally, we include a trade openness variable and a dummy for high income countries to proxy economic opportunities. Trade openness is calculated as the ratio of the sum of exports and imports to GDP. The inclusion of this measure is supported by an expectation that the more open a country is, the more the country will embrace the pros and cons of globalization, and thus social institutions will develop leading to more gender equality (e.g. Neumayer & de Soysa, 2007).

We shall mention that a dummy for high income nations enables us to calculate for the difference in gender (in)equality between high income and low income nations not accounted by our main variables.

The relevant statistics are taken from World Bank's World Development Indicators database and averaged out for a period of 2010-2012. The descriptive statistics are presented in Table 1 and the correlation matrix for main variables is supplied in Table A1.

Table 1
Descriptive statistics

Variable	Description	Source	Mean (Std. dev.)
SIGI	Social Institutions and Gender Index	OECD	19.098 (14. 356)
IQ	National IQ score	Lynn & Vanhanen (2012b)	84.102 (10.847)
Muslim	Share of population belonging to Muslim group	CIA Factbook	25.062 (36.932)
Left-wing	=1 if government is left-leaning	World Bank	0.318 (36.932)
Democracy	Mean of political rights and civil freedoms	Freedom House	4.675 (1.977)
Legal (f)	French legal origins	La Porta et al. (1999)	0.433 (0.497)
Legal (s)	Socialist legal origins	La Porta et al. (1999)	0.174 (0.380)
HIGHINCOME	=1 if high income country	World Bank	0.350 (0.478)
Trade (logged)	Bilateral trade as a % of GDP	World Bank	4.446 (0.470)

Methods

In order to estimate the impact of IQ on gender inequality, we estimate the following linear model:

$$SIGI_i = \beta_o + \beta_1 IQ_i + \beta_x CV_i + e_i \quad (1)$$

where the dependent variable is SIGI, a new measure of social institutions related to gender inequality. IQ is an average national intelligence, and CV is a set of control variables. Analyses were performed using STATA, version 11.2.

3. **Results**

Main results

Table 2 presents the main regression results. In model 1, we start with a simple bivariate regression without controlling for potential antecedents of gender (in)equality. We find that the coefficient for intelligence is negative and statistically significant at the 1% level. The restricted specification estimates provide general support for the model with an adjusted R^2 of 0.326. Particularly, a 10-point increase in IQ score is associated with an 8.2 point reduction in SIGI.

However, this negative link may be caused by the effect of excluded antecedents of gender inequality that are spuriously correlated with intelligence. Models 2 to 5 are stepwise regressions where we include other control variables in sequence. We add the share of Muslims and left-wing parties in model 2. The signs of control variables are in line with related studies. The orientation of the government is not significant, however. The association of intelligence with the response variable preserves its statistical significance.

In model 3, introducing the democracy index from Freedom House, a measure that captures the quality of democratic institutions, does not change the findings much. The positive relation of democracy to gender equity corresponds to the findings of Brown (2004). Adding legal origins (model 4) improves the share of total variance in gender inequality explained by the model (adj. R^2=0.594). The coefficient for intelligence retains its significance: $p<.05$.

Finally, in model 6 we introduce proxies for economic opportunities. In line with Potrafke & Ursprung (2012), we document that women enjoy greater equality in more open and democratic countries and less equality in countries with British legal origins (reference group).

Table 2
Main results: OLS regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IQ	-0.819***	-0.661***	-0.592***	-0.418***	-0.421***	-0.429***	-0.307***
	(0.099)	(0.091)	(0.090)	(0.118)	(0.126)	(0.124)	
Muslim		0.167***	0.145***	0.148***	0.149***	0.149***	0.402***
		(0.029)	(0.030)	(0.029)	(0.029)	(0.030)	
Left-wing		-3.090	-2.844	-3.155*	-3.130*	-3.115*	-0.103*
		(1.970)	(1.863)	(1.763)	(1.784)	(1.786)	
Democracy			-1.812***	-2.178***	-2.197***	-2.039***	-0.242***
			(0.607)	(0.629)	(0.682)	(0.695)	
Legal (f)				-5.647**	-5.644**	-5.716**	-0.202***
				(2.446)	(2.457)	(2.475)	
Legal (s)				-8.389**	-8.374**	-8.081**	-0.246***
				(3.478)	(3.501)	(3.444)	
HI					0.302	0.719	0.014
					(2.830)	(2.879)	
Trade (log)						-2.009**	-0.097**
						(0.765)	
Constant	85.110***	68.473***	56.228***	45.648***	45.796***	55.584***	-
	(8.428)	(7.839)	(8.890)	(10.334)	(10.581)	(10.658)	
N	107	106	106	106	106	105	105
adj. R^2	0.326	0.534	0.570	0.594	0.590	0.613	0.613

Notes: Standardized betas are reported in model 7. Heteroskedasticity adjusted robust standard errors in parentheses. Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level.

However, the results in Table 3 may be substantially biased by the traditional limitation of the mean regression approach, namely homogeneity of parameters (e.g. Durlauf & Johnson, 1995). The conventional mean regression assumptions ignore the dissimilarity of nations, and imply that intelligence has the same association with gender inequality across the sample. To address this concern we re-estimate our main model using quantile regression approach with heteroskedasticity-adjusted standard errors (e.g. Koenker, 2005; Hao & Naiman, 2007). While it has been frequently used in empirical economics (e.g. Canarella & Pollard, 2004), many articles that contribute to the understanding of intelligence are uninformed of it 'as it was developed relatively recently and is rarely taught in statistical courses at many universities' (Cade & Noon, 2003 p. 412). The reported results in Table 3 indicate that the negative impact of intelligence is greater in countries with a higher level of inequality.

In particular, the coefficients in Table 3 range from 0.334 to 0.459 and they are all statistically significant.[1] These results further indicate that intelligence exerts a quantitatively weighty contribution to explain gender inequality, which must not be ignored considering the role of intelligence in fostering social capital and institutional arrangements pinpointed in ample studies.

Table 3
Main results: quantile regressions

	(1) Q 0.2	(2) Q 0.4	(3) Q 0.5	(4) Q 0.6	(5) Q 0.8
IQ	-0.334*	-0.406***	-0.459***	-0.375***	-0.436*
	(0.172)	(0.123)	(0.118)	(0.129)	(0.223)
Muslim	0.113***	0.158***	0.163***	0.186***	0.126**
	(0.040)	(0.026)	(0.023)	(0.026)	(0.049)
Democracy	-1.786*	-2.131***	-2.124***	-2.250***	-4.038***
	(0.958)	(0.641)	(0.592)	(0.682)	(1.319)
N	105	105	105	105	105

Heteroskedasticity adjusted robust standard errors in parentheses. Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level. Other control variables include logged trade, HIGHINCOME, legal origins and left-wing.

On the other hand one may argue that cross-national studies have a critical drawback that limits their value for policy suggestions – the direction of causality. In particular, nations with stronger gender institutions may invest more in the human capital of female individuals and thus have

[1] The exact levels of significance of the IQ coefficients at the first and last quantiles are equal to 0.0551 and 0.0535 respectively. This indicates that the probability of committing a Type I error in each case is insignificantly higher than conventionally used level of 0.05.

higher national IQ (reverse causality). Therefore, controlling for the feedback effect that runs from gender equality to intelligence is crucial in our empirical exercise which otherwise may give rise to a so-called simultaneous equation bias. Furthermore, it may be a case that IQ and SIGI are correlated with another unobserved variable that is not included into our regression. This may lead to an omitted variable bias. These problems are special cases of an endogeneity problem in econometrics. The main trouble with the use of OLS method in regressions that contain one or more endogenous variables is that the OLS estimators in such cases are biased as well as inconsistent (see e.g. Engle et al., 1983; Gujarati, 2011).

A conventional way to address an endogeneity problem in empirical economics is to apply the instrumental variables (IV) method (see e.g. Stock & Watson, 2012). Since an endogenous regressor in our model is intelligence, our task is to select such variables that are linked to gender inequality *only* through their association with intelligence. In essence, these 'proxy' or 'substitute' variables (instruments) for intelligence should not be directly related to gender inequality. Although there is no universally accepted set of such instruments for intelligence we use historical prevalence of infectious diseases index and ultraviolet (UV) exposure of population as the instruments that are associated with intelligence in origin. For example, Eppig et al. (2010) used global data and showed that cross-national distribution of intelligence is correlated with the historical prevalence of infectious diseases. Furthermore, infections in the human body may be linked to cognitive development by having effect on genes entangled in the formation of neurons and linkages between them (Deverman & Patterson, 2012). Indeed, related literature reports that infectious disease prevalence significantly impairs the accumulation of cognitive abilities (Ijaz, & Rubino, 2012) and human capital formation (e.g. Schultz, 2003; Chakraborty et al., 2010).

In the same vein, similar studies suggest that ultraviolet exposure has a detrimental association with cognitive abilities (Silber et al., 1992; Templer & Arikawa, 2006[2]). For instance, a recent article by Leon (2015) documents that UV exposure explains the geographic differences in the cognitive abilities in the USA.

Leaning on these studies, we use data on pathogen prevalence from Murray & Schaller (2010) and on ultraviolet exposure from Ashraf & Galor (2010) in our analysis. One should note that these two variables may be considered as appropriate instruments for intelligence since they don't have a direct relationship with gender (in)equality.

Once an instrument selection process is completed, we should proceed with the design of the IV method as follows: First, we regress the potentially endogenous variable (IQ) against its instrument(s) (Z_{ni}) and calculate the predicted values for IQ_i (IQ_i^) (1st stage). And then we use those fitted values (IQ_i^) in the main equation as an independent variable (2nd stage). This estimation approach is called Two-Stage Least Squares (2SLS) method. The process has the following specification:

$$IQ_i = \gamma_o + \gamma_1 Z_{ni} + \gamma_x CV_i + v_i \qquad \text{(1st stage)}$$

$$SIGI_i = \beta_o + \beta_1 IQ_i\hat{} + \beta_x CV_i + e_i \qquad \text{(2nd stage)}$$

The estimates for 2SLS and a robust regression approach are reported in Table 4. Model 1 shows that intelligence is negatively associated with gender inequality even when we control for potential 'dual' causality between IQ and SIGI. It is important to note that the estimates for IQ are now quantitatively larger. A one-point increase in predicted intelligence is associated with a 1.13 point reduction in rescaled SIGI. The goodness-of-fit measure of the model (adj. R-squared) from the first stage regression shows that the variation in instruments explains approximately 59% of the

[2] See MacKie (2000); Solomon (2008) for further related evidence.

variation in IQ. These instruments capture variations in intelligence reasonably well: they are negative and statistically significant at 5% level. For example, in model 2, a one standard deviation increase in the UV exposure is associated with 3.8 point reduction in IQ. The strength of the instruments is also confirmed by the first stage F-statistics (*F=15.95; p=.00*).

Further, the results in cross-national studies are particularly sensitive to specific (influential) observations which cannot be adequately accounted in the empirical exercises with the mean (OLS) regressions. Indeed, Edgeworth (1887) argues that by minimizing the squared residuals, OLS is very easily affected by the presence of such observations (outliers). Moreover, Swartz & Welsch (1986, p. 171) assert: "OLS and many other commonly used maximum likelihood techniques have an unbounded influence function; any small subset of the data [abnormal or outlier-present observations, in particular] can have an arbitrarily large influence on their coefficient estimates." This is why as a further test for robustness, in model 3 of Table 4, we replicate the results using a robust regression (RREG) technique[3] that fits the model assigning lower weights to observations with an extreme effect (outliers) on a predictor variable (Li, 1985)[4]. The results indicate that the value of the IQ coefficient is 0.406 and statistically significant at the 1% level. To exemplify, this relationship shows that for a change in mean country IQ from 79 (Nicaragua) to 88.6 (Turkey) the rescaled SIGI falls by approximately 3.9 points.

Table 4
Main results: IV & RREG

	(1)	(2)	(3)
	IV	IV	RREG
Stage	2^{nd}	1^{st}	-
Dependent variable	SIGI	IQ	SIGI

[3] Robust regression (rreg) is an alternative technique to OLS regression. It is used to control for cases when data is characterized as having outliers or influential observations. This technique helps retain those observations in regression by moderating their influence on the coefficient estimate.
[4] See Hamilton (1991, 1992) for a more detailed review of rreg.

IQ	-1.130***		-0.406***
	(0.297)		(0.131)
Muslim	0.153***	-0.027	0.157***
	(0.032)	(0.021)	(0.027)
Left-wing	-1.215	2.970*	-3.194
	(2.301)	(1.565)	(2.062)
Democracy	-1.750**	-0.166	-1.913***
	(0.771)	(0.527)	(0.686)
Legal (f)	-2.226	4.098**	-5.395**
	(3.253)	(1.695)	(2.417)
Legal (s)	5.173	6.959**	-6.671*
	(5.807)	(2.938)	(3.401)
HIGHINCOME	8.631*	4.751	0.801
	(4.597)	(3.209)	(4.194)
Trade (log)	-2.263**	-1.559	-2.164
	(0.930)	(1.021)	(1.398)
UV exposure		-0.050**	
		(0.021)	
Pathogen prevalence		-5.506**	
		(2.201)	
Constant	108.530***	96.558***	53.554***
	(23.512)	(7.870)	(12.598)
N	95	95	105
adj. R^2	0.501	0.589	0.551
First stage F-stat	-	15.95	-
(p-value)		(0.00)	

Heteroskedasticity adjusted robust standard errors in parentheses. Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level.

Robustness tests

We check the robustness of our findings in a number of ways. First, we re-estimate Eq. (1) using an alternative vector of control variables: variation of GDP per capita that is not explained by intelligence (*GDP per capita residual*) and dummies for geographical regions. The GDP per capita residual represents cross-national differences in GDP per capita that are not explained by intelligence (intelligence-irrelevant level of economic development). To obtain this measure we regress logged GDP per capita on IQ and save the residuals.

We also include a KOF index as an alternative measure of openness (Samimi et al., 2012). Further, abundance of natural resources may increase social inequality and reduce women's prospects for employment. Working in a primary sector of extracting natural resources is capital-intensive and vocationally-discriminative in favor of men. Driven by the expected labor demand and earnings, households invest more resources in human capital of sons (over daughters) (e.g. Alderman & King, 1998). We therefore include fuel exports as a percentage of merchandise exports for the years 2003-2013 from World Development Indicators.

While mineral resource dependence is positively associated with gender inequality, intelligence and IQ-irrelevant level of GDP per capita are negatively linked with gender inequality.

Table 5
Robustness checks: alternative controls

	(1) OLS	(2) OLS Standardized betas
IQ	-0.821***	-0.592***
	(0.266)	
GDP per person (residual)	-4.125**	-0.268**
	(1.803)	
Globalization index (KOF)	0.099	0.090
	(0.157)	
Fuel exports	0.110**	0.206**
	(0.045)	
Constant	74.566***	-
	(19.636)	
N	101	101
adj. R^2	0.597	0.597

Notes: Standardized betas are reported in column 3. Heteroskedasticity adjusted robust standard errors in parentheses. Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level. Regional dummies for developing countries included but not reported.

We also test the estimates of IQ to see if they are sensitive to the measure of income. Henderson et al. (2012) argues that '[r]elative to developed countries, in many developing countries a much smaller fraction of economic activity is conducted within the formal sector, the degree of economic integration and price equalization across regions is lower, and, most significantly, the government statistical infrastructure is weaker. These factors make the calculation of nominal GDP (total value added, in domestic prices) difficult' (p. 992). To address this issue, we use a statistical framework that estimates GDP per capita for developing countries in our sample based on the 'visible light, byproduct from human activity, emitted from earth as captured by a series of US Air Force weather satellites' (Salahodjaev, 2015a p. 132). The results reported in Table 6 show that the association of intelligence with the outcome variable still remains intact. For example, the reader may argue that when thinking about the association between intelligence and gender (in)equality, one should also recognize that apart from estimates residuals may also be driven by regional differences or differences in GDP per capita. Thus, residuals may be heteroscedastic as we incorporate nations from various regions with their own converging clubs by GDP per capita. To resolve this issue we use Weighted Least Squares (WLS) regression with logged GDP per person and regional dummies as the weight function. The estimates in model 4 show that IQ is now significant at the 1% level and similar in magnitude to the estimates under OLS regression.

Table 6
Robustness checks: intelligence and measures of income

	(1) OLS	(2) OLS	(3) IV	(4) WLS
IQ	-0.460**	-0.469**	-1.594**	-0.429***
	(0.211)	(0.203)	(0.765)	(0.101)
GDP per capita (log)	-1.962	-2.795*	-1.128	-1.775**
	(1.284)	(1.591)	(2.428)	(0.784)
Constant	66.187***	75.029***	147.552***	83.038***
	(19.733)	(21.270)	(45.316)	(9.652)
N	105	104	94	104
adj. R^2	0.535	0.536	0.401	0.782
GDP per capita	World Bank	Predicted	Predicted	Predicted

Notes: Standardized betas are reported in column 3. Standard errors in parentheses. Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level. We include regional dummies for developing countries to control for within-region differences in gender inequality and intelligence.

Finally, we replaced SIGI index with Gender Inequality Index (GII) from Human Development Report[5] to examine whether a negative association of intelligence with gender inequality is affected by the choice of the dependent variable (not reported here). The estimates indicate that this is not the case. Intelligence retains its statistical significance and negative association with gender inequality in developing nations.

Indirect relationship of intelligence

As previously conjectured, it is plausible that intelligence may have an indirect connection to gender equality through democratic institutions, or economic development. In this context, the reduction in magnitude of the coefficient for intelligence in Table 2 may be a signal for the presence of an indirect relationship in the intelligence-gender equality nexus. To explore these possibilities, a path analysis was performed. Figure 1 shows that the anticipated positive indirect link of IQ runs through the democratic institutions (significant at the 1% level). In line with Forsythe et al. (2000), we fail to detect the impact of economic development on gender equality. In addition, Baliamoune-Lutz (2007) argues that economic development in some regions of the world contributed to greater gender inequality.

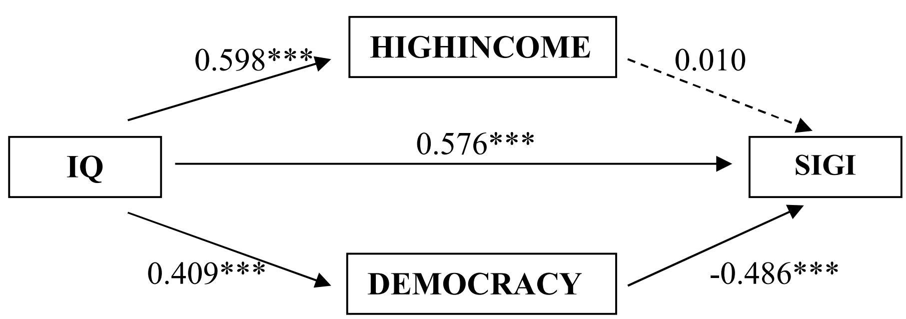

Fig 1. Standardized path estimates between intelligence, democracy index, HIGHINCOME and SIGI (gender inequality). Significance at the 1% level is denoted by ***; ** denotes significance at the 5% level; and * significance at the 10% level. Path estimates above *p>0.05* are indicated by dotted lines.

[5] See http://hdr.undp.org/en/content/gender-inequality-index-gii

4. **Conclusion**

This study has investigated the possible association of intelligence on gender inequality using data on SIGI and IQ scores for the period 2010–2013. The results show that there is a robustly negative link between intelligence and gender inequality. In particular, the estimates for intelligence show that for a change in mean country IQ from 79 (Nicaragua) to 88.6 (Turkey) the rescaled SIGI falls by approximately 3.9 points. The negative association of intelligence with gender inequality preserves its sign and significance even after we introduce a wide range of control variables as suggested by the literature.

Consequently, the findings of this study further shed light on the major question discussed within development literature – why are some countries associated with greater gender inequality?

In particular, we document that intelligence has an indirect association with gender equity through civic behavior. From a macroeconomic perspective, it may be feasible to increase the quality of political institutions through investing in cognitive skills and education. Indeed, recent publications claim that nations with higher IQ have better rule of law (Kanyama, 2014) and lower corruption (Potrafke, 2012). From a political viewpoint the results of this study may be elucidated in line with Glaeser et al. (2007) who show that human capital increases the benefits of civic participation.

The results of 2SLS regression may also bring about some useful implications. If historical prevalence of infectious diseases has an adverse connection to intelligence, then disease eradication policy may foster gender equality in a society.

On the other hand, our research has a number of limitations associated mainly with the quality of cross-national IQ data. One of the possible shortcomings of our study is the fact that repeated data on IQ scores are not available for developing nations. Due to the cross-sectional nature of the data, the implementation of more sophisticated approaches such as panel data regressions or estimations using generalized method of moments (GMM) is not feasible. Further, the intelligence scores for some countries are predicted based on IQ tests for neighboring countries with similar culture. However, in their seminal work Lynn & Vanhanen (2012a) show that these predictions are robust. On the other hand, the estimates of quantile regression provided an opportunity, through the cross-sectional nature of the data, to explore the heterogeneous impact of intelligence on gender inequality. The results remain valid and significant. Consequently, future research should further explore the link between IQ and the gender gap on the individual level using perceptions of gender roles on society drawn from cross-national surveys such as the World Values Survey or Gallup World Poll.

References

Acemoglu, D. K., Robinson, J., & Johnson, S. (2001). The Colonial Origins of Comparative Development: An Empirical Investigation. *American Economic Review*, *91*(5), 1369-1401.

Albouy, D. Y. (2012). The colonial origins of comparative development: an empirical investigation: comment. *The American Economic Review*, 3059-3076.

Alderman, H. & King, E. M. (1998). Gender Differences in Parental Investment in Education. *Structural Change and Economic Dynamics, 9*(4), 453-468.

Ashraf, Q. & Galor, O. (2013). The 'Out of Africa' Hypothesis, Human Genetic Diversity, and Comparative Economic Development. *American Economic Review, 103*(1), 1-46.

Avdeyeva, O. (2009). Enlarging the Club: When do Candidate States Enforce Gender Equality laws&quest. *Comparative European Politics*, *7*(1), 158-177.

Baliamoune-Lutz, M. (2007) 'Globalisation and Gender Inequality: Is Africa Different?', *Journal of African Economies, 16(*2), 301–48.

Beer, C. (2009). Democracy and gender equality. *Studies in Comparative International Development*, *44*(3), 212-227.

Branisa, B., Klasen, S. & Ziegler, M. (2013). Gender Inequality in Social Institutions and Gendered Development Outcomes. *World Development*, Vol. 45, 252–268.

Branisa, B., Klasen, S., Ziegler, M., Drechsler, D., & Jütting, J. (2014). The Institutional Basis of Gender Inequality: The Social Institutions and Gender Index (SIGI). *Feminist Economics,* 20(2), 29-64.

Brown, D. S. (2004). Democracy and gender inequality in education: a cross-national examination. *British Journal of Political Science*, *34*(01), 137-152.

Burhan, N. A. S., Sidek, A.H., Kurniawan, Y., & Mohamad, M. R. (2015). Has globalization triggered collective impact of national intelligence on economic growth?. *Intelligence*, *48*, 152-161.

Cade, B. S., & Noon, B. R. (2003). A gentle introduction to quantile regression for ecologists. *Frontiers in Ecology and the Environment*, *1*(8), 412-420.

Canarella, G., & Pollard, S. (2004). Parameter heterogeneity in the neoclassical growth model: a quantile regression approach. *Journal of Economic Development*, *29*, 1-32.

Chakraborty, S., Papageorgiou, C., & Sebastián, F. P. (2010). Diseases, infection dynamics, and development. *Journal of Monetary Economics*, *57*(7), 859-872.

Chattopadhyay, R. & Duflo, E. (2004). Women as Policy Makers: Evidence from a Randomized Policy Experiment in India, *Econometrica, 72*(5), 1409-1443.

Cohen, P. N. (2004). The gender division of labor "Keeping house" and occupational segregation in the United States. *Gender & Society*, *18*(2), 239-252.

Dahlerup, D. (2005). Increasing women's political representation: New trends in gender quotas. *Women in Parliament: Beyond Numbers*, 141.

Deary, I. J., Batty, G. D., & Gale, C. R. (2008). Childhood intelligence predicts voter turnout, voting preferences, and political involvement in adulthood: The 1970 British Cohort Study. *Intelligence*, *36*(6), 548-555.

Dollar, D., Fisman, R. & Gatti, R. (2001). Are Women Really the "Fairer" Sex? Corruption and Women in Government, *Journal of Economic Behavior & Organization, 46*, 423-429.

Davenport, K. S., & Remmers, H. H. (1950). Factors in state characteristics related to average A-12 V-12 test scores. *Journal of Educational Psychology, 41*, 110−115.

Deverman, B. E, & Patterson, P. H. (2009). Cytokines and Cns Development. *Neuron, 64*, 61-78.

Dee, Th. S. (2004). Are there civic returns to education? *Journal of Public Economics, 88*, 1697−1720.

Durlauf, S. N., & Johnson, P. A. (1995). Multiple Regimes and Cross-Country Growth Behavior, *Journal of Applied Econometrics, 10*, 365-384.

Edgeworth, F.Y. (1887). On observations relating to several quantities. *Hermathena, 6*, 279-285.

Engle, R.F., Hendry, D.F. & Richard, J.-F.. (1983). Exogeneity, *Econometrica, 51*, 277–304.

Eppig, C., Fincher, C. L., & Thornhill, R. (2010). Parasite prevalence and the worldwide distribution of cognitive ability. *Proceedings of the Royal Society B, 277*, 3801–3808.

Esteve-Volart, B. (2000). Sex Discrimination and Growth, IMF Working Paper WP/00/84, Washington DC: African Department, International Monetary Fund

Forsythe, N., Korzeniewicz, R. P., & Durrant, V. (2000). Gender inequalities and economic growth: A longitudinal evaluation. *Economic Development and Cultural Change, 48*(3), 573–617

Glaeser, E., Ponzetto, G., & Shleifer, A. (2007). Why does democracy needs education? *Journal of Economic Growth, 12*, 77-99.

Gujarati, D. (2011). *Econometrics by Example.* Palgrave MacMillan, London.

Hamilton, L. C. (1991). How robust is robust regression? *Stata Technical Bulletin, 2*, 21–26.

Hamilton, L. C. (1992). *Regression with Graphics: A Second Course in Applied Statistics*. Belmont, CA: Duxbury

Hao, L., & Naiman, D. Q. (2007). *Quantile Regression*. Thousand Oaks, CA: Sage.

Henderson, V., Storeygard, A., & Weil, D. (2012). Measuring economic growth from outer space. *The American Economic Review, 102*, 994–1028.

Ijaz, M. K., & Rubino, J. R. (2012). Impact of infectious diseases on cognitive development in childhood and beyond: potential mitigational role of hygiene.*Open Infectious Diseases Journal*, *6*(1), 65-70.

Inglehart, R. (1997). *Modernization and post modernization. Cultural, economic, and political change in 43 societies.* Princeton: Princeton University Press.

Inglehart, R., Norris, P., & Welzel, C. (2002). Gender equality and democracy.*Comparative Sociology*, *1*(3), 321-345.

Jayachandran, S. (2015). The Roots of Gender Inequality in Developing Countries. *Annual Review of Economics*, *7*(1).

Jüttig, J., Luci, A., & Morrison, C. (2010). Why do so many women end up in bad jobs? A cross-country assessment. Working Paper no. 287, OECD Development Centre. Paris.

Klasen, S., Schüler, D. (2011). Reforming the Gender-Related Development Index and the Gender Empowerment Measure: Implementing some specific proposals. *Feminist Economics,* Vol. 17, 1–30.

Koenker, R. (2005). *Quantile Regression.* New York: Cambridge University Press.

Kanazawa, S. (2009). IQ and the Values of Nations. *Journal of Biosocial Science, 41*, 537–556.

Kanyama, I. K. (2014). Quality of institutions: Does intelligence matter?. *Intelligence*, *42*, 44-52.

La Porta, R., Lopez-di-Silanes, F., Shleifer, A., & Vishny, R. (1999). The quality of government. Journal of Law, *Economics and Organization, 15*, 222–279.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2008). The economic consequences of legal origins. *Journal of Economic Literature*, *46*(2), 285-332.

Li, G. (1985). *Robust regression. In Exploring Data Tables, Trends, and Shapes*, ed. D. C. Hoaglin, C. F. Mosteller, and J. W. Tukey, 281–340. New York: Wiley

Lipset, S. M. (1960). *Political man. The social bases of politics.* New York: Doubleday.

Lopez-Claros, A. & Zahidi, S. (2005). Women's Empowerment: Measuring the Global Gender Gap. Geneva: World Economic Forum.

Lynn, R., & Vanhanen, T. (2002). *IQ and the wealth of nations*. Westport, CT: Praeger Publishers

Lynn, R., & Vanhanen, T. (2012a). National IQs: A review of their educational, cognitive, economic, political, demographic, sociological, epidemiological, geographic and climatic correlates. *Intelligence*, *40*(2), 226-234.

Lynn, R. & Vanhanen, T. (2012b). *Intelligence. A unifying construct for the social sciences*. London: Ulster Institute for Social Research.

Lynn, R., & Meisenberg, G. (2010). National IQs calculated and validated for 108 nations. *Intelligence*, *38*(4), 353-360.

MacKie, R. M. (2000). Effects of ultraviolet radiation on human health. *Radiation Protection Dosimetry*, *91*(1-3), 15-18.

Meisenberg, G. (2004). Talent, character, and the dimensions of national culture. *Mankind Quarterly, 45*, 123−168.

Meisenberg, G., & Lynn, R. (2011). Intelligence: A measure of human capital in nations. *Journal of Social, Political and Economic Studies*, *36*(4), 421-454.

Millet, K., & Dewitte, S. (2007). Altruistic behavior as a costly signal of general intelligence. *Journal of Research in Personality*, *41*(2), 316-326.

Milligan, K., Moretti, E., & Oreopoulos, P. (2004). Does education improve citizenship? Evidence from the U.S. and the U.K. *Journal of Public Economics, 88*, 1667−1695.

Morrisson, Ch. & Jütting, J.P. (2005). Women's Discrimination in Developing Countries: A New Data Set for Better Policies. *World Development,* 33(7), 1065–81.

Murray, D. R., & Schaller, M. (2010). Historical prevalence of infectious diseases within 230 geopolitical regions: A tool for investigating origins of culture. *Journal of Cross-Cultural Psychology*, *41*(1), 99-108.

Neumayer, E. & de Soysa, I. (2007). Globalization, Women's Economic Rights and Forced Labour. *The World Economy*, 30(10), 1510-1535.

Norris, P., & Inglehart, R. (2001). Cultural obstacles to equal representation. *Journal of democracy*, *12*(3), 126-140.

Phillips, A. (1997). *What has Socialism to do with Sexual Equality?* in J. Franklin (ed.) Equality, London: IPPR, 101-121

Potrafke, N. (2012). Intelligence and corruption. *Economics Letters*, *114*(1), 109-112.

Potrafke, N., & Ursprung, H. W. (2012). Globalization and gender equality in the course of development. *European Journal of Political Economy*, *28*(4), 399-413.

Ram, R. (2007). IQ and economic growth: Further augmentation of Mankiw–Romer–Weil model. *Economics Letters, 94*, 7–16

Rao, A., & Kelleher, D. (2003). Institutions, organizations and gender equality in an era of globalisation. *Gender & Development*, *11*(1), 142-149.

Salahodjaev, R. (2015a). Intelligence and shadow economy: A cross-country empirical assessment. *Intelligence*, *49*, 129-133.

Salahodjaev, R. (2015b). Democracy and economic growth: The role of intelligence in cross-country regressions. *Intelligence*, *50*, 228-234.

Salahodjaev, R. (2015c). Intelligence and finance. *Personality and Individual Differences*, *86*, 282-286.

Samimi, J.A., Ghaderi, S., Hosseinzadeh, R., & Nademi, Y. (2012). Openness and inflation: New empirical panel data evidence. *Economics Letters*, *117*(3), 573-577.

Schultz, T. P. (2003). Human capital, schooling and health. *Economics & Human Biology*, *1*(2), 207-221.

Silber, J. H., Radcliffe, J., Peckham, V., Perilongo, G., Kishnani, P., Fridman, M., Goldwein, J.W. & Meadows, A. T. (1992). Whole-brain irradiation and decline in intelligence: the influence of dose and age on IQ score. *Journal of Clinical Oncology*, *10*(9), 1390-1396.

Simpson, M. (1997). Informational inequality and democracy in the new world order. In M. Midlarsky (Ed.), *Inequality, democracy, and economic development* (pp. 156−176). Cambridge: Cambridge University Press.

Social Watch Report. (2005). *Roars and Whispers Gender and Poverty: Promises vs. Action.* Montevideo: Social Watch.

Solomon, K. R. (2008). Effects of ozone depletion and UV-B radiation on humans and the environment. *Atmosphere-Ocean*, *46*(1), 185-202.

Solon, I. S. (2014). How intelligence mediates liberalism and prosociality. *Intelligence, 47*, 44-53.

Stankov, L. (2009). Conservatism and cognitive ability. *Intelligence*, *37*(3), 294-304.

Stock, J. H., & Watson, M. W. (2012). *Introduction to Econometrics: Global Edition*. Pearson Education.

Swartz, S & Welsch, R. E. (1986). Applications of bounded influence and diagnostic methods in energy modelling, in: Belsley, D. A. & Kuh, E. (eds), *Model Reliability*. MIT Press, Cambridge, MA.

Templer, D. I., & Arikawa, H. (2006). Temperature, skin color, per capita income, and IQ: An international perspective. *Intelligence, 34*(2), 121-139.

United Nations Development Program (UNDP). (2010). *Human Development Report 2010. The Real Wealth of Nations: Pathways to Human Development.* New York: Palgrave Macmillan.

Voracek, M. (2004). National intelligence and suicide rate: an ecological study of 85 countries. *Personality and Individual Differences*, *37*(3), 543-553.

World Bank (2001). *Engendering Development: Through Gender Equality in Rights, Resources and Voices.* New York, NY: World Bank/Oxford University Press.

Zou, H. F. (1991). Socialist economic growth and political investment cycles. *European Journal of Political Economy*, *7*(2), 141-157.

Table 1A.
Correlation matrix

	SIGI	IQ	UV damage	Pathogen index	Muslim	Left-wing	Democracy	Legal (f)	Legal (s)	HIGHINCOME	Trade (log)
SIGI	1										
IQ	-0.57	1									
UV damage	0.43	-0.70	1								
Pathogen index	0.55	-0.67	0.78	1							
Muslim	0.57	-0.21	0.04	0.16	1						
Left-wing	-0.22	0.04	0.19	0.07	-0.22	1					
Democracy	-0.49	0.28	-0.29	-0.44	-0.31	0.14	1				
Legal (f)	0.05	-0.14	0.28	0.28	0.21	0.02	-0.06	1			
Legal (s)	-0.30	0.56	-0.68	-0.52	-0.16	-0.09	-0.01	-0.55	1		
HIGHINCOME	-0.40	0.49	-0.52	-0.55	-0.24	-0.07	0.51	-0.05	0.17	1	
Trade (log)	-0.19	0.07	-0.23	-0.27	-0.06	0.01	0.20	-0.08	0.06	0.17	1