

Economics and Fertility

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Introduction

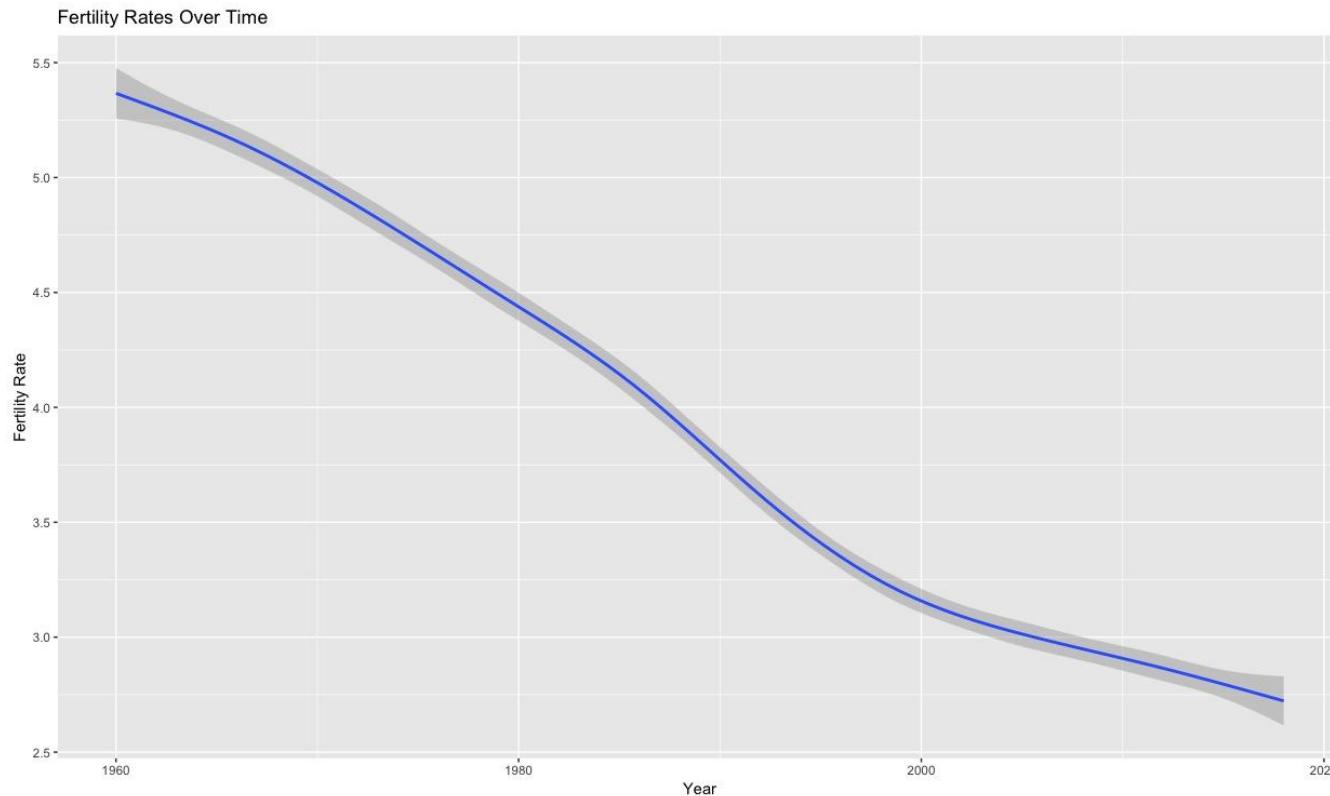
Project Prompt

- Economists view childbearing as economic decision
- Simple Model
 - Decision between “consuming” children and goods
- There has been a steady decline in fertility rates
- Income and fertility are negatively correlated
 - Suggests children are “inferior goods”
- Is there a more plausible explanation?

Introduction

- The average rate has fertility rate has fallen by more than fifty percent in the last sixty years
- It is a multifaceted subject that seems to possess strong correlational ties to both social and economic development
- Decline in the average fertility rate of 4.7 children per woman to 2.4 children per woman
- “One of the most fundamental social changes that happened in human history. It is therefore especially surprising how very rapidly this transition can indeed happen.” (Roser)
- Strong convergence between developed and less developed countries

Graphical Representation of Fertility Rates

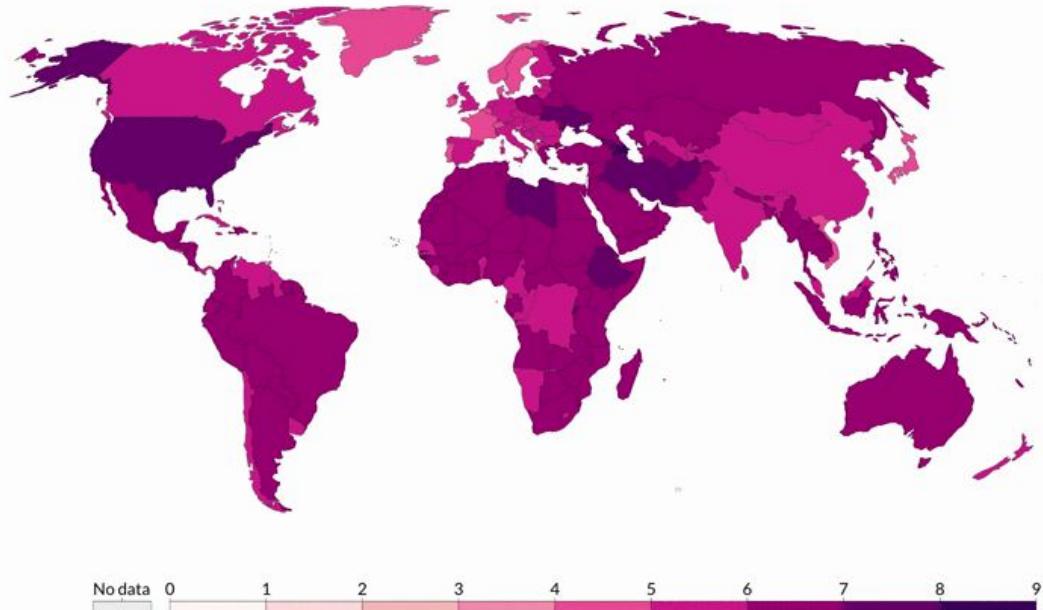


Visual Change in Fertility by Country

Children born per woman, 1799

Shown is the 'Total Fertility Rate' which measures the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with the age-specific fertility rates of the specific year.

Our World
in Data



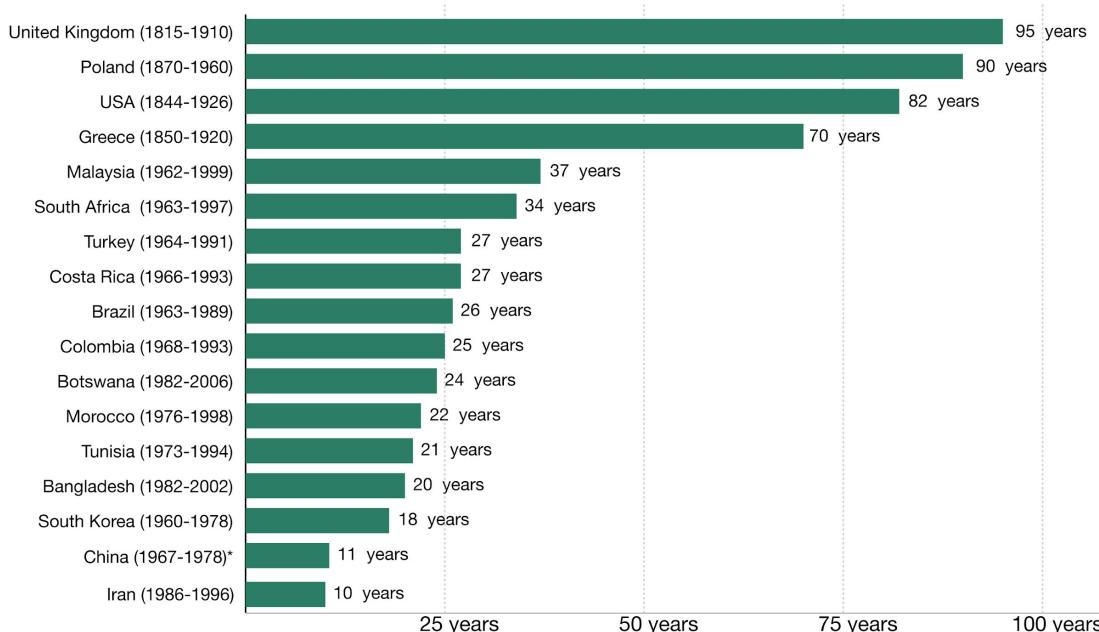
Source: Gapminder for estimates until 1949; UN Population Division for 1950 to 2015

OurWorldInData.org/fertility-rate • CC BY

Rapid Reduction in Fertility

How long did it take for fertility to fall from more than 6 children per woman to fewer than 3 children per woman?

OurWorld
in Data



* The one-child-policy in China was introduced after the decline of the total fertility rate below 3. It was introduced between 1978 and 1980.

Data source: The data on the total fertility rate is taken from the Gapminder fertility dataset (version 6) and the World Bank World Development Indicators.

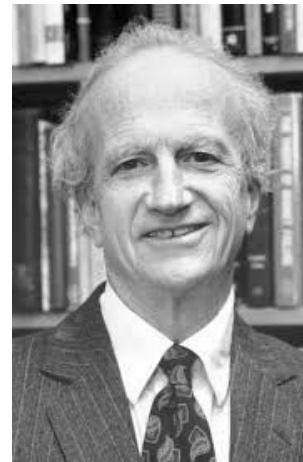
The interactive data visualization is available at OurWorldInData.org. There you find the raw data and more visualizations on this topic.

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Current Theories

Gary S. Becker

- Parents derive utility from both child quantity and the quality of children
- Knowledge of birth control (or the lack thereof) is a possible determinant of fertility



Quantity/Quality Model

- Increases in family size decrease parental investment, decrease childhood performance on cognitive tests and measures of social behavior.
- The negative effects on cognitive abilities are much larger for girls, while the detrimental effects on behavior are larger for boys



Income and Development Model

- Diane Macunovich (1996)
 - An increase in the male's relative income will cause a rise in fertility while an increase in female wages will produce downward pressure on fertility.
- Butz & Ward (1977)
 - Labor force participation rate of women and their earnings increased significantly, contributed to a decline in fertility.

Pronatalist Vs. Antinatalist

Pronatalist Policies

- Policies that encourage or are in favor of childbearing
- Israel
- Subsidizing maternity leave
- Monetary benefits to families with more children



Antinatalist Policies

- Policies aimed at reduction of childbearing
- China's "one child policy"
- Abortion mandatory if another child is conceived
- Increasingly common in developing countries in order to combat high fertility rates



Regression Analysis

Data

- Collected our data from The World Bank
 - Database: World Development Indicators
- Covers 264 Countries/Regions
- Spans from 1960 to 2018
- 41 Unique Variables

Imputation

- Largest issue was missing data
- Method to resolve this issue: Multiple Imputation
- First, need to determine how the data is missing
 - Missing at Random (MAR)
 - Missing Completely at Random (MCAR)
 - Missing Not at Random (MNAR)
- Our data was Missing at Random (MAR)
 - Could be imputed from its relation to the patterns in the available data

Imputation Continued

- We used R and read the data into RStudio
- Used the MICE (Multivariate Imputation via Chained Equations) Package
 - Assumes variables to be Missing at Random (MAR)
 - Methods: Predictive Mean Matching, Logistic Regression, Bayesian Polytomous Regression, Proportional Odds Model
- Ran five iterations on the data set

Imputation Continued

- To understand difference between the predicted values and observed values
 - Calculate the Normalized-Root-Mean-Square-Error/Deviation
- NRMSE:

$$RMSE = \sqrt{\frac{\sum_{t=1}^T (x_{1,t} - x_{2,t})^2}{T}}$$

$$NRMSE = \frac{RMSE}{y_{max} - y_{min}} \text{ or } NRMSE = \frac{RMSE}{\bar{y}}$$

- Calculated RMSE of 0.06
 - Our predicted data is quite accurate--value of zero would indicate a perfect fit

Variables

- Began with 69 variables
 - Topics:
 - National Income
 - GDP per Capita
 - Educational Attainment
 - Health Care
 - Labor Force Participation
 - Contraception
 - Etc.
- With so many variables, potential issue of multicollinearity

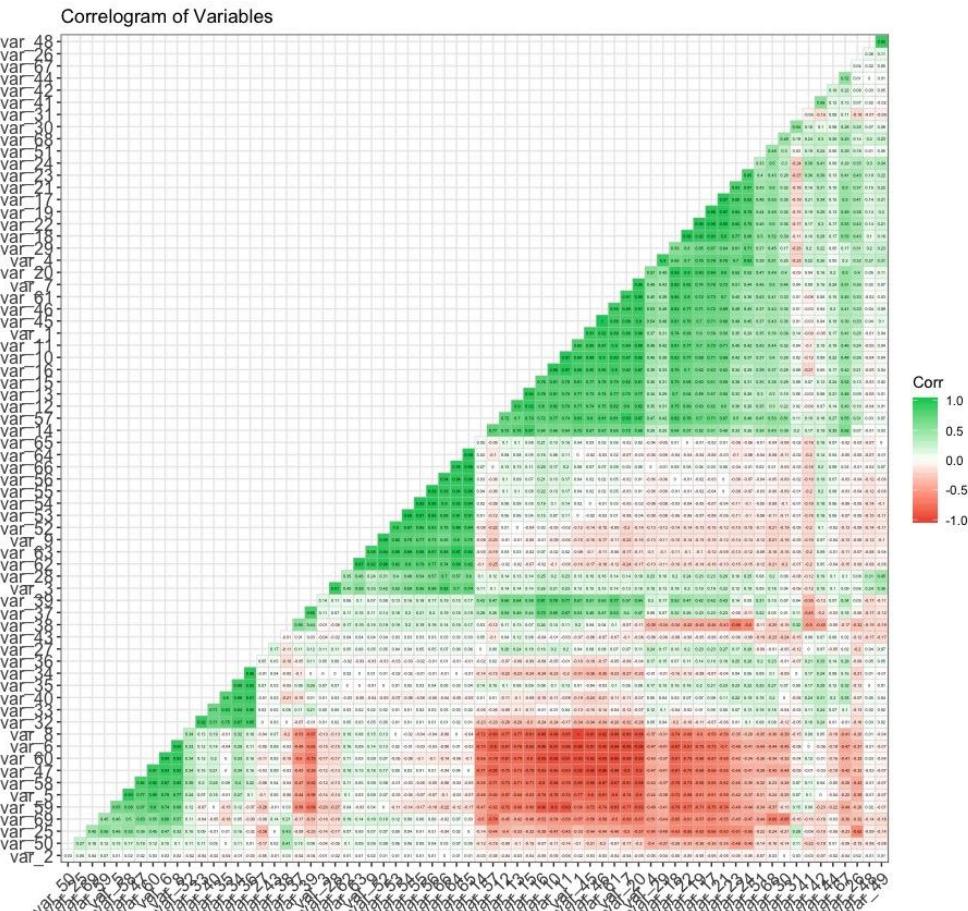
Multicollinearity

- When a predictor variable within the multiple regression model can be linearly predicted from other variables within the model
- In STATA, used the VIF (Variance Inflation Factor) function to determine the correlation between the variables
 - Shows how much the variance of the coefficient estimate is being inflated by multicollinearity
- Additionally, we constructed a correlation matrix to help us determine which variables to use in our final regression
 - The matrix displays the correlation between the coefficients of the variables
 - High correlation between two variables would indicate an issue of multicollinearity

VIF Results

Variable	VIF	1/VIF
var_1	634.86	0.001575
var_8	624.08	0.001602
var_64	262.05	0.003816
var_55	244.14	0.004096
var_56	239.35	0.004178
var_46	221.23	0.004520
var_54	214.19	0.004669
var_63	210.71	0.004746
var_45	197.79	0.005056
var_65	184.83	0.005418
var_53	171.10	0.008539
var_20	100.98	0.009933
var_62	49.55	0.010577
var_66	98.1	0.010900
var_36	88.40	0.011312
var_18	82.89	0.012064
var_22	79.62	0.012560
var_16	74.66	0.013393
var_34	73.83	0.013544
var_11	67.81	0.014747
var_10	64.74	0.015447
var_52	55.45	0.018036
var_60	51.49	0.019422
var_6	51.22	0.019522
var_17	41.28	0.024224
var_61	36.83	0.027153
var_21	36.65	0.027284
var_19	34.98	0.028586
var_7	34.07	0.029351
var_15	32.97	0.030330
var_58	25.64	0.038995
var_59	19.70	0.050764
var_47	19.65	0.050890
var_57	16.27	0.061457
var_32	15.93	0.062772
var_9	15.48	0.064591
var_12	13.63	0.073389
var_35	13.60	0.073520
var_33	13.45	0.074345
var_13	13.41	0.074547
var_23	12.25	0.081639
var_3	11.85	0.084361
var_4	11.80	0.084742
var_24	11.69	0.085538
var_39	11.34	0.088172
var_5	11.01	0.090795
var_40	11.00	0.090880
var_38	10.06	0.099448
var_49	9.77	0.102355
var_14	9.58	0.104365
var_28	9.41	0.106258
var_48	8.10	0.123467
var_37	8.03	0.124554
var_29	5.77	0.173217
var_69	5.66	0.176707
var_25	5.17	0.193371
var_30	3.85	0.259424
var_67	3.83	0.261211
var_68	3.44	0.290518
var_26	3.10	0.322003
var_31	2.83	0.353572
var_41	2.82	0.354097
var_27	2.76	0.361995
var_42	2.68	0.372459
var_51	2.07	0.483119
var_44	2.01	0.497898
var_50	1.66	0.601954
var_43	1.42	0.704867
var_2	1.04	0.963732
Mean VIF	68.06	

Correlation Matrix Results



Multicollinearity Results

- After correlation analysis, in order to avoid an issue of multicollinearity, we were able to reduce the number of variables to 41
- Example of some of the variables removed:
 - Adolescents out of school, female (% of female lower secondary school age)
 - Children out of school, female (% of female primary school age)
 - Contraceptive prevalence, modern methods (% of women ages 15-49)
 - GDP (current US\$)
 - Government expenditure on education, total (% of government expenditure)
 - Labor force with advanced education, female (% of female working-age population with advanced education)
 - Labor force with basic education, female (% of female working-age population with basic education)
 - Labor force with intermediate education, female (% of female working-age population with intermediate education)

Data Summary

. summarize						
Variable	Obs	Mean	Std. Dev.	Min	Max	
entity	0					
year	18085	1991.028	16.8002	1960	2018	
fertility_e	18085	3.808505	1.809682	.827	8.866	
adjusted_n_p	18085	78.63388	21.53263	4.90081	99.99557	
adjusted_n_	18085	4368.567	7775.492	-51.56165	82019.95	
adolescent_e	18085	31.18159	24.55892	.01229	97.29541	
births_att_t	18085	70.61668	25.7063	5	100	
contracept_t	18085	45.41696	21.2851	1.7	96	
demand_fam_e	18085	52.0667	21.55364	3.6	96.3	
female_edu_	18085	6.810563	6.210734	0	37.31714	
fem_wer_seco	18085	34.44095	23.8283	.2	100	
female_edu_n	18085	8.940939	8.656416	0	68.17269	
female_ay_pe	18085	52.46666	28.10432	.58823	100	
female_edu_t	18085	7.777788	7.485937	0	63.68967	
fem_per_seco	18085	23.10181	18.53047	.07377	96.43464	
female_as_pe	18085	1.912772	2.453182	0	28.71104	
female_edu_p	18085	.1133767	.1350215	0	2.38246	
exp_mary_edu	18085	38.92372	7.340337	1.258	98.66846	
exp_dary_edu	18085	33.44942	5.749308	0	79.39564	
exp_iary_edu	18085	18.25168	5.029201	0	68.13506	
gdp_per_ca_a	18085	5904.402	12293.43	34.74143	185152.5	
labor_forc_e	18085	50.80167	11.26832	5.823	90.784	
female_d_edu	18085	83.35886	4.576303	58.2505	100	
female_c_edu	18085	69.51729	9.972002	20.123	96.42	
female_lab_	18085	72.68136	7.082022	22.99	95.6824	
female_lab_l	18085	40.32106	6.305118	7.664765	55.90509	
law_equal_a	18085	.2881946	.4529347	0	1	
law_nondis_i	18085	.4415814	.4965893	0	1	
law_paid_u_e	18085	.985347	.1201629	0	1	
law_prohib_e	18085	.7197125	.4491521	0	1	
life_expec_h	18085	64.70788	10.0269	18.907	85.41708	
life_expec_e	18085	67.12992	10.61541	22.394	87.14	
infant_~1000	18085	52.3496	42.02106	1.6	267.5	
net_primar_e	18085	-1.11e+09	1.01e+10	-7.96e+10	2.22e+11	
gender_non_	18085	.9050041	.2932173	0	1	
nonpregnan_e	18085	.2498203	.4329209	0	1	
m~10_incom_a	18085	2.37e+07	7.23e+07	5000	8.09e+08	
m~25_incom_a	18085	4790281	1.50e+07	0	1.79e+08	
pregnant_w_	18085	80.79455	15.39576	15.4	100	
unmet_need_n	18085	19.46385	6.979663	1.7	55.9	
women_make_s	18085	52.29114	15.57499	4.9	81	
female_sha_m	18085	28.03566	3.79737	9.35	55.81	
percent_goo_o	18085	10.19496	3.006061	.765524	34.41215	
out_of_poc_e	18085	39.9305	15.14508	.0913182	94.78466	

Estimated Equation

$$Y = \beta_0 + \beta_1(\text{adjusted_net_enrollment_female_p})_i + \beta_2(\text{adjusted_net_national_income_us})_i + \beta_3(\text{adolescents_out_of_school_female})_i + \beta_4(\text{births_attended_by_skilled_healt})_i + \beta_5(\text{contraceptive_prevalence_any_met})_i + \beta_6(\text{demand_family_planning_modern_me})_i + \beta_7(\text{female_edu_attainment_bachelors})_i + \beta_8(\text{female_edu_attainment_lower_seco})_i + \beta_9(\text{female_edu_attainment_post_secon})_i + \beta_{10}(\text{female_edu_attainment_primary_pe})_i + \beta_{11}(\text{female_edu_attainment_short_tert})_i + \beta_{12}(\text{female_edu_attainment_upper_seco})_i + \beta_{13}(\text{female_edu_attainment_masters_pe})_i + \beta_{14}(\text{female_edu_attainment_doctoral_p})_i + \beta_{15}(\text{expenditure_primary_edu})_i + \beta_{16}(\text{expenditure_secondary_edu})_i + \beta_{17}(\text{expenditure_tertiary_edu})_i + \beta_{18}(\text{gdp_per_capita})_i + \beta_{19}(\text{labor_force_participation_female})_i + \beta_{20}(\text{female_labor_force_advanced_edu})_i + \beta_{21}(\text{female_labor_force_basic_edu})_i + \beta_{22}(\text{female_labor_force_intermediate})_i + \beta_{23}(\text{female_labor_force_total})_i + \beta_{24}(\text{law_equal_renumeration_male_fema})_i + \beta_{25}(\text{law_nondiscrimination_gender_in_hi})_i + \beta_{26}(\text{law_paid_unpaid_maternity_leave})_i + \beta_{27}(\text{law_prohibits_child_marriage})_i + \beta_{28}(\text{life_expectacncy_at_birth})_i + \beta_{29}(\text{life_expectacncy_at_birth_female})_i + \beta_{30}(\text{infant_mortality_rate_per_1000})_i + \beta_{31}(\text{net_primary_income})_i + \beta_{32}(\text{gender_nondiscrimination_clause})_i + \beta_{33}(\text{nonpregnant_women_same_job_as_me})_i + \beta_{34}(\text{more_than_10_income_on_health_ca})_i + \beta_{35}(\text{more_than_25_income_on_health_ca})_i + \beta_{36}(\text{pregnant_women_receive_prenatal})_i + \beta_{37}(\text{unmet_need_for_contraception})_i + \beta_{38}(\text{women_make_own_sexual_decisions})_i + \beta_{39}(\text{female_share_employment_senior_m})_i + \beta_{40}(\text{percent_government_expenditure_o})_i + \beta_{41}(\text{out_of_pocket_health_expenditure})_i + \varepsilon_i$$

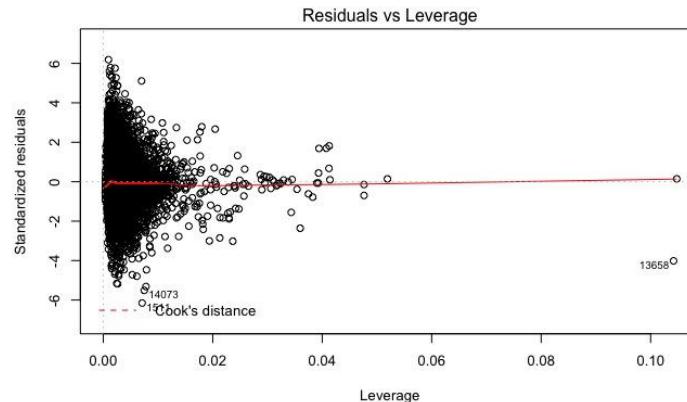
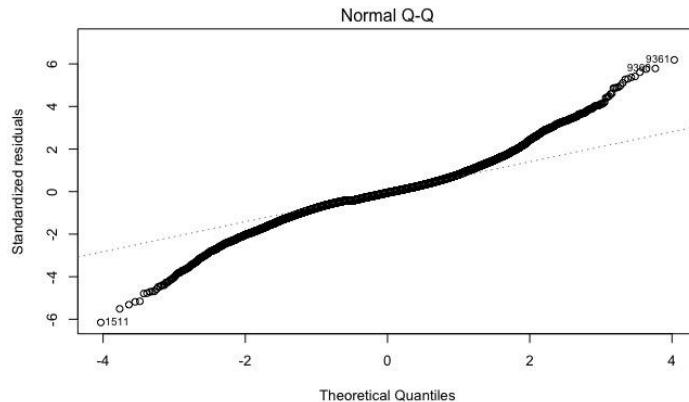
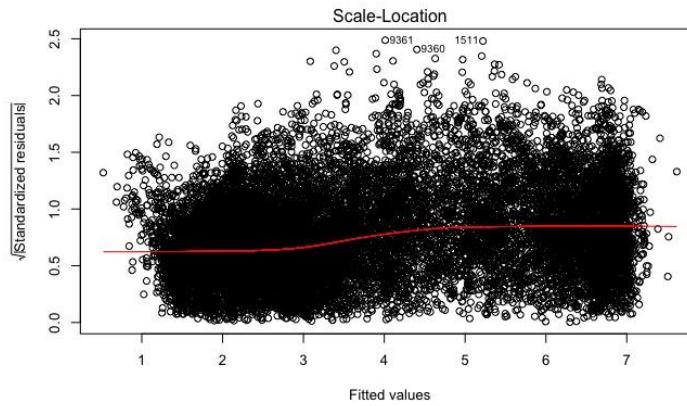
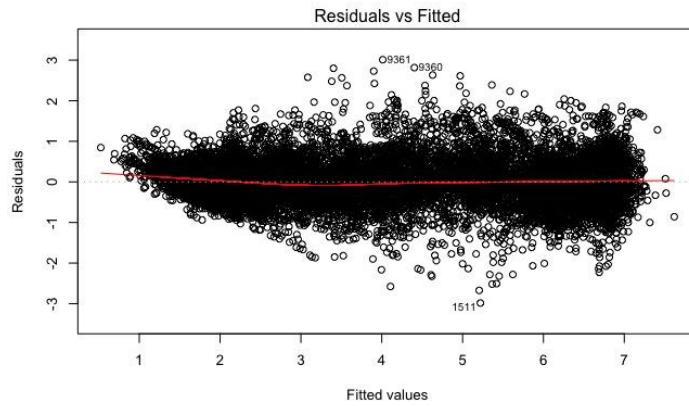
Regression Results

- Number of Observations = 18085
- F(41, 18043) = 5655.29
- R-Squared = 0.9278
- Adjusted R-Squared = 0.9276

Source	SS	df	MS	Number of obs = 18085				
Model	54948.3259	41	1340.20307	F(41, 18043)	= 5655.29			
Residual	4275.8717	18043	.236982383	Prob > F	= 0.0000			
Total	59224.1976	18084	3.2749501	R-squared	= 0.9278			

	fertility_rate	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
adjusted_net_enrollment_female_p	.0005702	.0008683	0.66	0.511	-.0011317	.0022722
adjusted_net_national_income_us_adolescents_out_of_school_female	-8.47e-07	1.56e-06	-0.54	0.587	-3.90e-06	2.21e-06
births_attended_by_skilled_health	-.008621	.0010168	-0.85	0.397	-.0028551	.0011309
contraceptive_prevalence_any_met	-.0413696	.0011328	-36.52	0.000	-.0435899	-.0391493
demand_family_planning_modern_me	.0006937	.0009281	0.75	0.455	-.0011254	.0025128
female_edu_attainment_bachelors_	.0031376	.003602	0.87	0.384	-.0039226	.0019798
female_edu_attainment_lower_seco	.0098218	.0013167	7.46	0.000	.0072409	.0124027
female_edu_attainment_post_secon	-.0208978	.0023231	-9.00	0.000	-.0254513	-.0163442
female_edu_attainment_primary_pe	-.0294516	.0012117	-24.31	0.000	-.0318266	-.0270766
female_edu_attainment_short_ert	.0347549	.0028696	12.11	0.000	.0291302	.0043797
female_edu_attainment_upper_seco	.0057727	.0017029	3.39	0.001	.0024348	.0091105
female_edu_attainment_masters_pe	-.0364633	.0049939	-7.30	0.000	-.0462518	-.0266748
female_edu_attainment_doctoral_p	-.0894463	.0881517	-1.01	0.310	-.2622322	.0833395
expenditure_primary_edu	.0086555	.0010628	8.14	0.000	.0065723	.0107387
expenditure_secondary_edu	.0005875	.0010835	0.54	0.588	-.0015363	.0027113
expenditure_tertiary_edu	.0062718	.0011295	5.55	0.000	.0040578	.0084857
gdp_per_capita	1.83e-06	6.95e-07	2.63	0.009	4.65e-07	3.19e-06
labor_force_participation_female	-.002975	.0008991	-3.31	0.001	-.0047373	-.0012127
female_labor_force_advanced_edu	.0410094	.0021268	19.28	0.000	.0368406	.0451781
female_labor_force_basic_edu	-.0031864	.0010827	-2.94	0.003	-.0053086	-.0010643
female_labor_force_intermediate_	.0158846	.001588	10.00	0.000	.0127721	.0189971
female_labor_force_total	-.014218	.0016075	-8.84	0.000	-.0173688	-.0110672
law_equal_renumeration_male_fema	.0037433	.0128828	0.29	0.771	-.0215882	.0289947
law_nondiscrimination_gender_in_hi	.0005452	.0115315	0.05	0.962	-.0220576	.0231479
law_paid_unpaid_maternity_leave	-.1478739	.0338181	-4.37	0.000	-.2141607	-.0815871
law_prohibits_child_marriage	.0160278	.011041	1.45	0.147	-.0056137	.0376692
life_expectancy_at_birth	.000333	.0050115	0.07	0.947	-.00949	.010156
life_expectancy_at_birth_female	-.0008959	.0049592	-0.18	0.857	-.0106164	.0088245
infant_mortality_rate_per_1000	-.0001809	.0003736	-0.48	0.628	-.0009133	.0005515
net_primary_income	-1.28e-12	4.17e-13	-3.07	0.002	-2.10e-12	-4.64e-13
gender_nondiscrimination_clause_	.1171723	.0154382	7.59	0.000	.0869276	.147417
nonpregnant_women_same_job_as_me	.0134115	.0116948	1.15	0.251	-.0095113	.0363344
more_than_10_income_on_health_ca	-4.13e-09	4.96e-10	-8.32	0.000	-.510e-09	-3.15e-09
more_than_25_income_on_health_ca	1.68e-08	2.37e-09	7.07	0.000	1.21e-08	2.14e-08
pregnant_women_receive_prenatal_	.0087439	.00091	9.61	0.000	.0069602	.0105276
unmet_need_for_contraception	.0089137	.002105	3.81	0.000	.0038878	.0121396
women_make_own_sexual_decisions	-.0446698	.0012833	-34.81	0.000	-.0471851	-.0421546
female_share_employment_senior_m	.0142222	.0016592	8.57	0.000	.0109699	.0174745
percent_government_expenditure_o	.0150944	.0020881	7.23	0.000	.0110016	.0191871
out_of_pocket_health_expenditure	-.0023886	.0005018	-4.76	0.000	-.0033721	-.001405
_cons	3.87915	.2469765	15.71	0.000	3.3950852	4.363248

Regression Visual



General Regression Analysis

- Residual errors versus fitted values
 - Randomly distributed around the horizontal line
 - Residual error of zero; no distinct trend in the distribution
- Q-Q Plot
 - The residual errors are normally distributed
- Scale-location plot
 - Square root of the standardized residuals as a function of the fitted values
 - No obvious trend
- Points leverage
 - Measure of importance in determining the regression result
- Overall, each visual correlates with a well-structured regression

Significance

	Full Regression Model bias
adjusted_net_enrollment_female_primary	0.00 (0.00)
adjusted_net_national_income_us_dollar	-0.000 (0.00)
adjusted_net_national_income_us_dollar	-0.001 (0.00)
births_attended_by_skilled_health_staff	-0.003*** (0.00)
contraceptive_prevalence_any_methods	0.014** (0.00)
demand_family_planning_modern_methods	0.001 (0.00)
female_edu_attainment_bachelors_percent	0.003 (0.00)
female_edu_attainment_lower_secondary_percent	0.010*** (0.00)
female_edu_attainment_post_secondary_percent	-0.021*** (0.00)
female_edu_attainment_primary_percent	-0.029*** (0.00)
female_edu_attainment_short_tertiary_percent	0.035*** (0.00)
female_edu_attainment_upper_secondary_percent	0.006*** (0.00)
female_edu_attainment_masters_percent	-0.036*** (0.00)
female_edu_attainment_doctoral_percent	-0.059 (0.00)
expenditure_primary_edu	0.009*** (0.00)
expenditure_secondary_edu	0.011 (0.00)
expenditure_tertiary_edu	0.000*** (0.00)
gdp_per_capita	0.049 (0.00)
labor_force_participation_female_15_plus	-0.033*** (0.00)
female_labor_force_advanced_edu	0.044*** (0.00)
female_labor_force_basic_edu	-0.003*** (0.00)
female_labor_force_intermediate_edu	0.017*** (0.00)
female_labor_force_total	-0.014*** (0.00)
law_equal_renumeration_male_female_in_work	0.004 (0.01)
law nondiscrimination_gender_in_hiring	0.001 (0.01)
law_gaid_tepaid_maternity_leave	-0.148*** (0.03)
law_prohibits_child_marriage	0.016 (0.01)
life_expectancy_at_birth	0.000 (0.01)
life_expectancy_at_birth_female	-0.001 (0.00)
infant_mortality_rate_per_1000	-0.000 (0.00)
net_primary_income	-0.000*** (0.00)
gender_nondiscrimination_clause_in_constitution	0.117*** (0.02)
nonpregnant_women_same_job_as_men	0.017 (0.01)
more_than_10_percent_income_on_health_care	-0.000*** (0.00)
more_than_29_percent_income_on_health_care	0.009*** (0.00)
pregnant_women_receive_prenatal_care	0.009*** (0.00)
unmet_need_for_contraception	0.009*** (0.00)
women_make_own_sexual_decisions	-0.045*** (0.00)
female_share_employment_senior_middle_manager	0.014*** (0.00)
percent_government_expenditure_on_health_care	0.015*** (0.00)
out_of_pocket_health_expenditure	-0.002*** (0.00)
constant	3.879*** (0.25)
R-sqr	0.928
F-rsq	25.634.8
DF2	

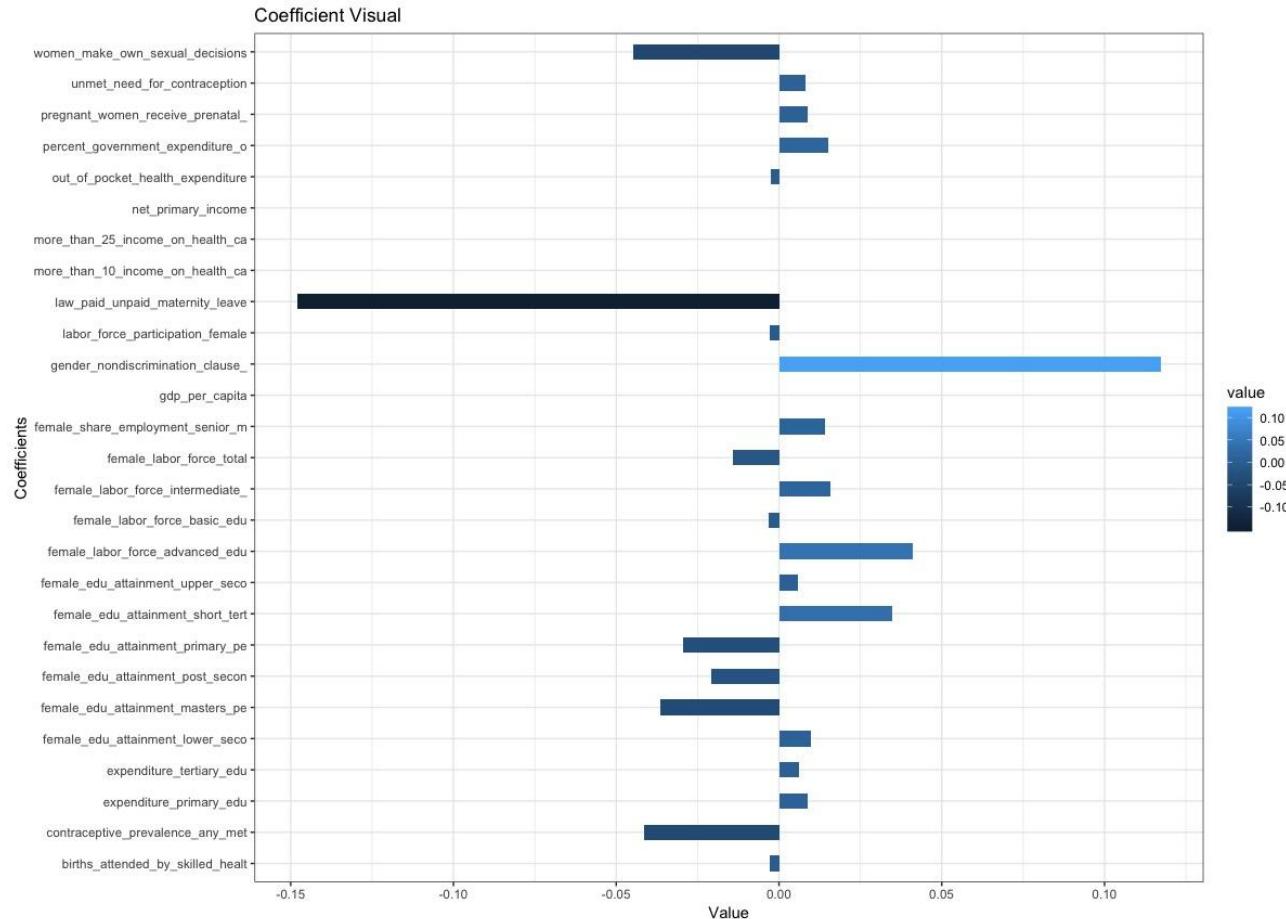
*p<0.05, **p<0.01, *** p<0.001

Variables of Statistical Significance From Full Regression

Statistically Significant Variables From Full Regression Model	
	Full Regression Model b/se
births_attended_by_skilled_health_staff	-0.003*** (0.00)
contraceptive_prevalence_any_methods	-0.011** (0.00)
female_edu_attainment_lower_secondary_percent	0.010*** (0.00)
female_edu_attainment_post_secondary_percent	-0.021*** (0.00)
female_edu_attainment_primary_percent	-0.029*** (0.00)
female_edu_attainment_short_tertiary_percent	0.035*** (0.00)
female_edu_attainment_upper_secondary_percent	0.006*** (0.00)
female_edu_attainment_masters_percent	-0.036*** (0.00)
expenditure_primary_edu	0.009*** (0.00)
expenditure_tertiary_edu	0.006*** (0.00)
gdp_per_capita	0.000** (0.00)
labor_force_participation_female_15_plus	-0.003*** (0.00)
female_labor_force_advanced_edu	0.041*** (0.00)
female_labor_force_basic_edu	-0.003** (0.00)
female_labor_force_intermediate_edu	0.016*** (0.00)
female_labor_force_total	-0.014*** (0.00)
law_paid_unpaid_maternity_leave	-0.148*** (0.03)
net_primary_income	-0.000** (0.00)
gender_nondiscrimination_clause_in_constitution	0.117*** (0.02)
more_than_10%_income_on_health_care	-0.000** (0.00)
more_than_25%_income_on_health_care	0.000*** (0.00)
pregnant_women_receive_prenatal_care	0.000*** (0.00)
unmet_need_for_contraception	0.008*** (0.00)
women_make_own_sexual_decisions	-0.045*** (0.00)
female_share_employment_senior_middle_manage	0.014*** (0.00)
percenta_government_expenditure_on_health_care	0.015*** (0.00)
out_of_pocket_health_expenditure	-0.002** (0.00)
constant	3.879*** (0.25)
R-sqr	0.928
dffes	
BIC	25634.8

* p<0.05, ** p<0.01, *** p<0.001

Significant Coefficients Visual



Regression Interpretation

Regression Interpretations

- Interpreting the correlation between educational attainment and fertility rate
- What is the importance of contraception?
- Is GDP the best measure of development?
- The impact of Health Care
- What do the dynamics of the Labor Force say about Fertility Rates?

Education

Education

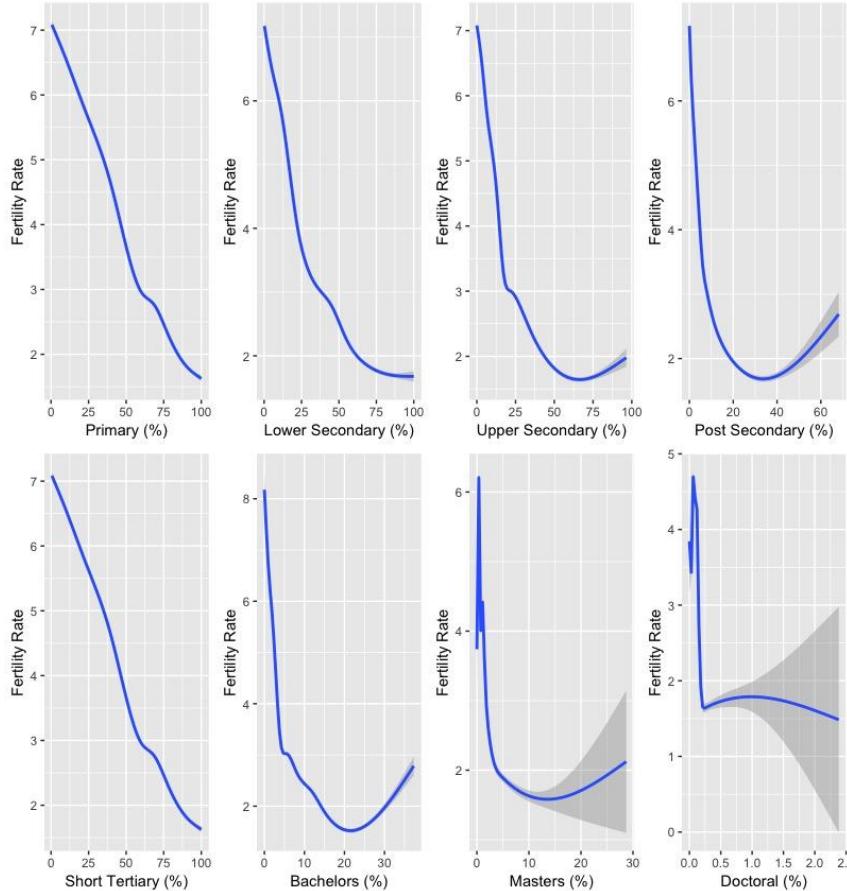
- Preconceived notion that there is a negative correlation between female educational attainment and fertility rate
 - This holds true when evaluated in a “vacuum”
- With a simple linear regression, each level of educational attainment has a statistically significant negative correlation with fertility rate

Female Education Significance

	Educational~ b/se	Female Bac~ b/se	Female Low~n b/se	Female Pos~t b/se	Female Pri~t b/se	Female Sho~t b/se	Female Upp~n b/se	Female Mas~t b/se	Female Doc~t b/se
female_edu_attainm~	-0.001 (0.00)	-0.212*** (0.00)							
female_edu_~wer_seco	0.039*** (0.00)		-0.064*** (0.00)						
female_edu_attainm~n	0.027*** (0.00)			-0.150*** (0.00)					
female_edu_atta~y_pe	-0.084*** (0.00)				-0.060*** (0.00)				
female_edu_attainm~t	-0.027*** (0.00)					-0.169*** (0.00)			
female_edu_~per_seco	-0.020*** (0.00)						-0.078*** (0.00)		
female_edu_atta~s_pe	0.030*** (0.00)							-0.364*** (0.00)	
female_edu_attainm~p	0.448*** (0.07)								-5.434*** (0.09)
constant	7.174*** (0.01)	5.256*** (0.01)	6.028*** (0.01)	5.149*** (0.01)	6.965*** (0.01)	5.122*** (0.01)	5.609*** (0.01)	4.504*** (0.01)	4.425*** (0.02)
R-sqr	0.892	0.532	0.720	0.514	0.873	0.488	0.637	0.243	0.164
dfres									
BIC	32623.3	59073.8	49764.3	59737.1	35482.9	60700.5	54483.6	67762.8	69548.5

* p<0.05, ** p<0.01, *** p<0.001

Correlation of Educational Attainment and Fertility Rate



Education Interpretation

- This is a correlational study, not a causal study
 - According to economist, in general, the more schooling women have the lower the fertility rate
 - However, what many believe to be a causal relationship, has never been proven and is still unclear
- On average, this negative correlation between education and fertility rate holds true
 - To exemplify the concept, it is better when studied in a developing area—the negative correlation is much greater
 - Not a world model like our regression
 - Why?

Development and Education

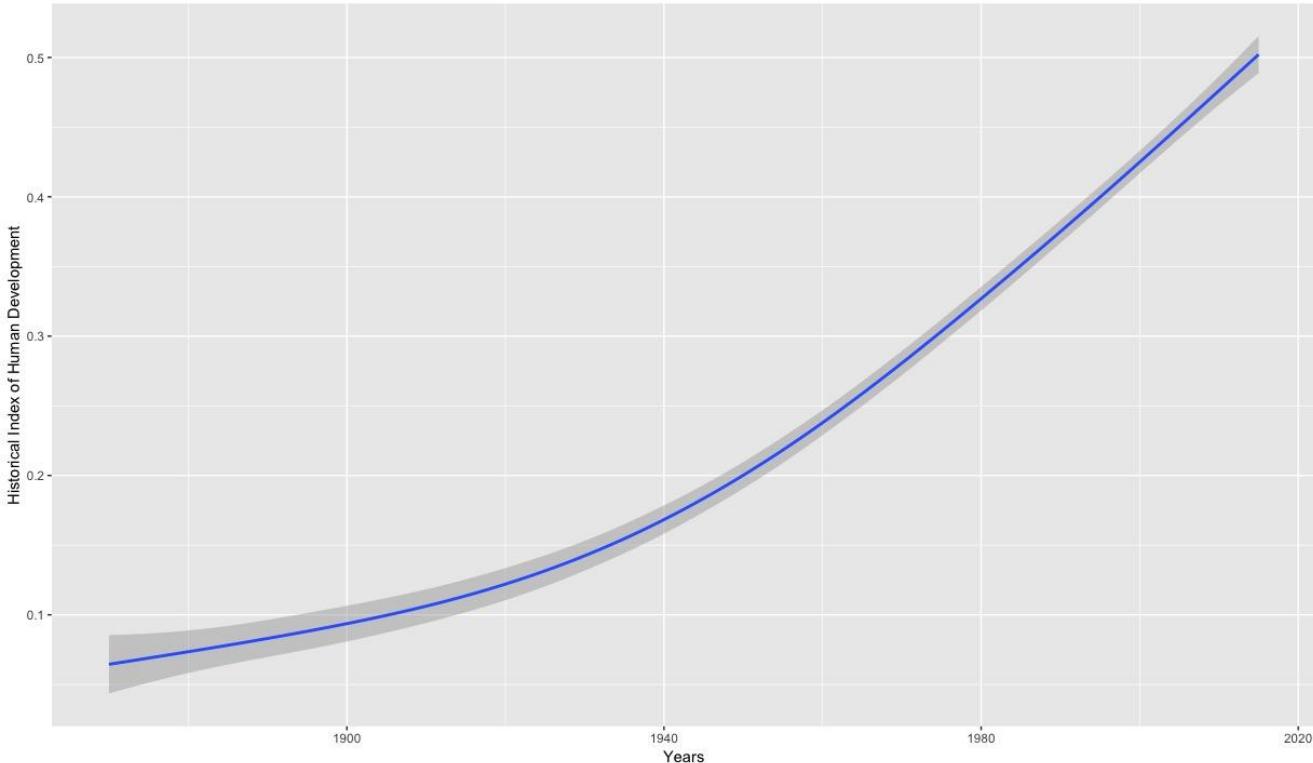
- We are beginning to see changes in the trends
 - The ultimate sustainable fertility rate is 2 (replacement rate)
 - As a world, we are very close to this (~2.4)
 - The world, on average, has “developed” exponentially in the past 60 years
 - In the developed world, female education has become quite “normal”
 - 76% of the countries around the world are considered to be “developed”
- As female education becomes even more normal and people continue to live longer
 - We remain steady around a fertility rate of 2
 - Educational attainment levels have begun to flatten out
 - The correlation between fertility rate and education is going to become more positive
 - We have already begun to see this occur

Development and Education Continued

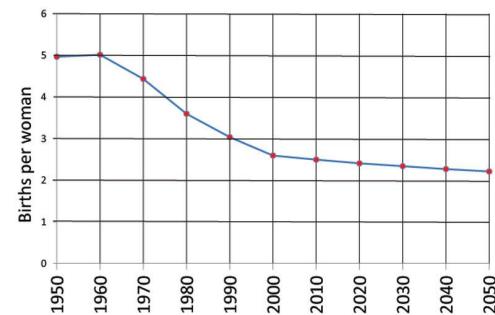
- Women with higher education marry men with higher education
 - Men have a positive relationship with education and fertility rate
 - They have a higher income, more children later in life

Visual of Development and Education

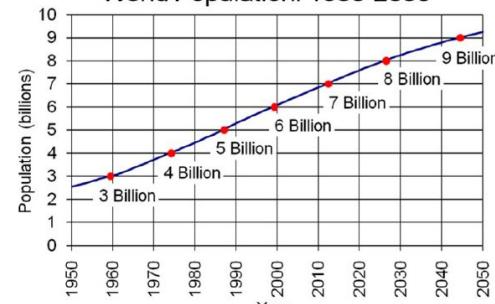
Human Development Through HIHD



Total Fertility Rates: 1950 - 2050

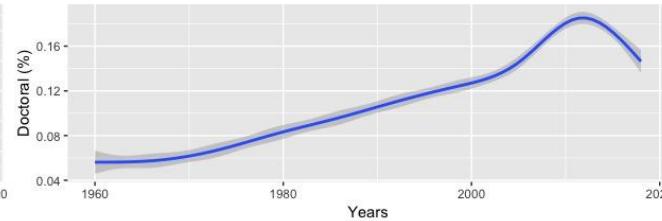
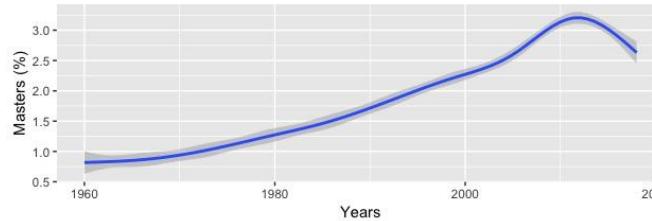
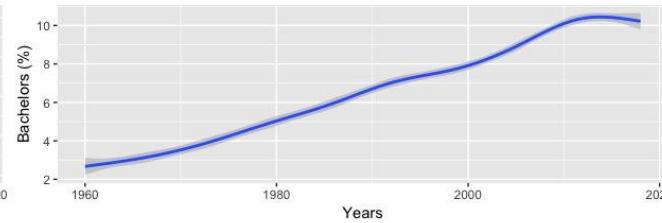
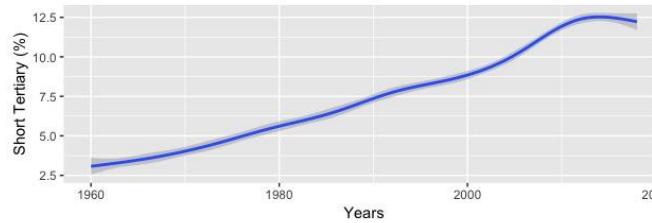
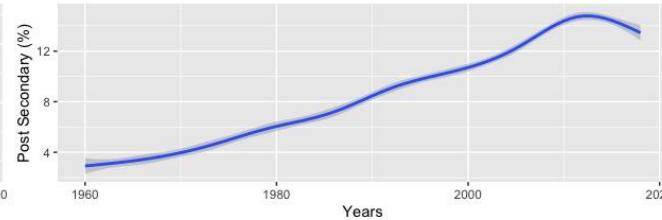
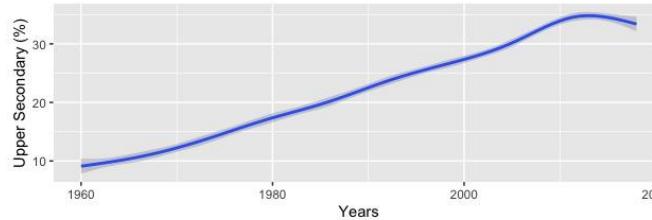
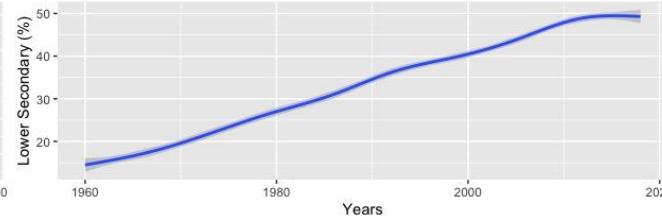
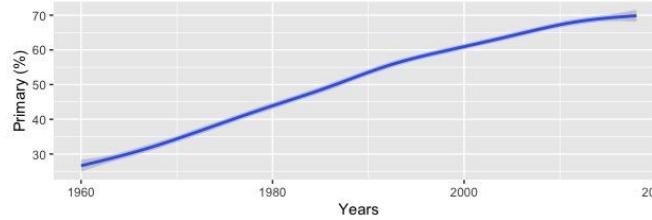


World Population: 1950-2050



Source: U.S. Census Bureau, International Data Base, December 2010 Update.

Educational Attainment Visual



Importance of Contraception

Contraception Interpretation

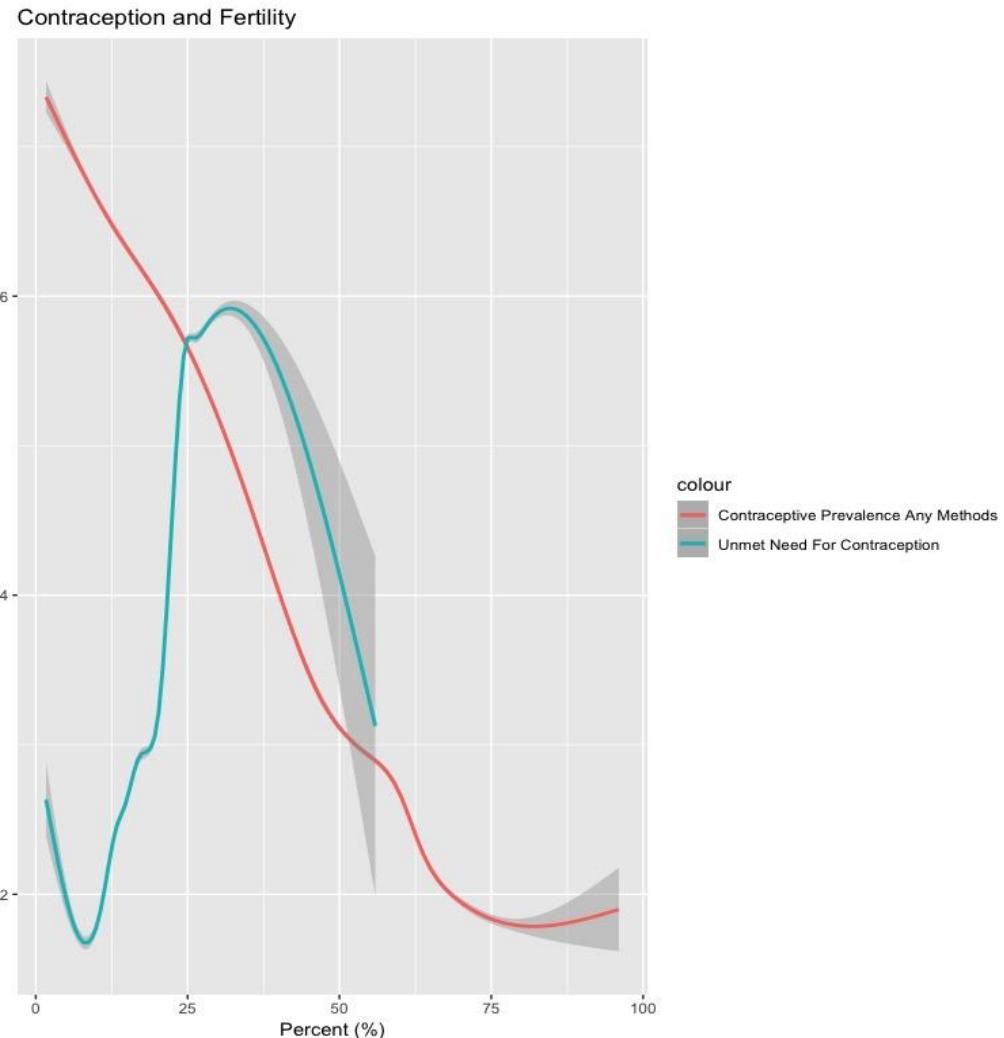
- Across all three models, access to contraception of any method has a statistically significant negative correlation with fertility rate
- Contrary to this, across the “Full Regression Model” and the “Contraception/Sexual Interaction Model”, unmet needs for contraception has a statistically significant positive correlation with fertility rate
- Importance of contraception:
 - Prevent pregnancy related health problems
 - Allows women the time to enhance their education
 - Reduce teenage pregnancy

Importance of Contraception

Contraception/Sexual Interaction Model

Variable	Full Regression Model	Contraception and Sexual Interaction Model	Contraception Model
contraceptive_prevalence_any_met	-0.041*** (0.00)	-0.052*** (0.00)	-0.079*** (0.00)
demand_family_planning_modern_me	0.001 (0.00)	0.017*** (0.00)	
law_prohibits_child_marriage	0.016 (0.01)	-0.040*** (0.01)	
unmet_need_for_contraception	0.008*** (0.00)	0.010*** (0.00)	0.002 (0.00)
women_make_own_sexual_decisions	-0.045*** (0.00)	-0.060*** (0.00)	

Graphical Correlation Between Contraception and Fertility Rate



GDP

GDP Regression and Significance

```
. regress fertility_rate gdp_per_capita
```

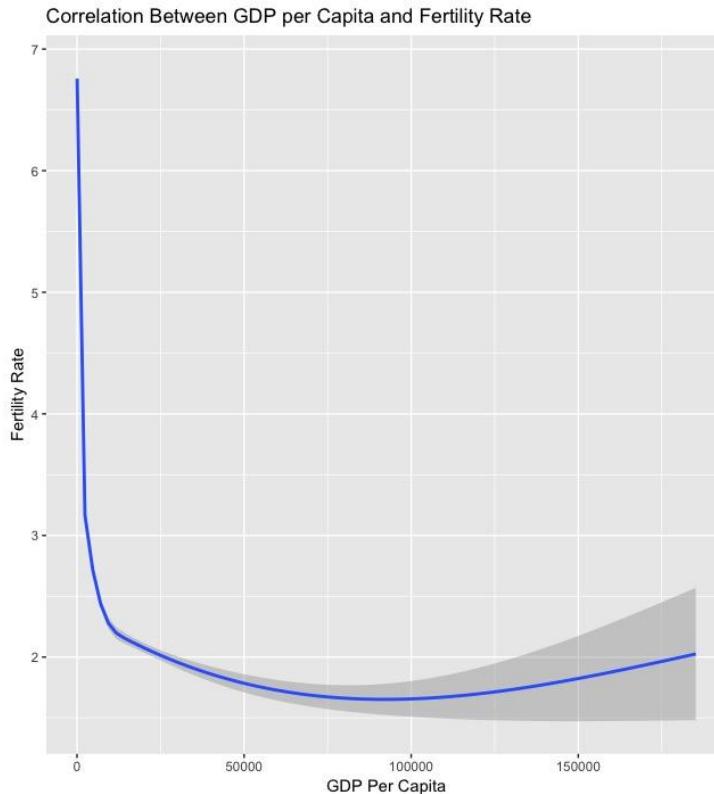
Source	SS	df	MS	Number of obs	=	18085
Model	9614.68613	1	9614.68613	F(1, 18083)	=	3504.62
Residual	49609.5114	18083	2.74343369	Prob > F	=	0.0000
Total	59224.1976	18084	3.2749501	R-squared	=	0.1623
				Adj R-squared	=	0.1623
				Root MSE	=	1.6563

fertility_rate	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
gdp_per_capita	-.0000593	1.00e-06	-59.20	0.000	-.0000613 -.0000573
_cons	4.15871	.0136635	304.37	0.000	4.131929 4.185492

GDP Model

Variable	Full Regression Model	GDP Model
gdp_per_capita	0.000** (0.00)	-0.000*** (0.00)

GDP Graphical Correlation with Fertility Rate



Evaluation of GDP

- Very similar conceptually to educational attainment
 - Significant negative correlation if singularly evaluated
 - General sign of “development”
 - Omitted variables, as there are multiple components to “development”
 - Correlational study vs. causal study
- Many flaws/failures that come with using GDP as a sign of development
 - Ignores distribution
 - Ignores externality/public goods
 - Markets are biased
 - Time dimensions
 - Deals with the means of achieving things, not whether they actually do

Health-Care

Health-Care Significance

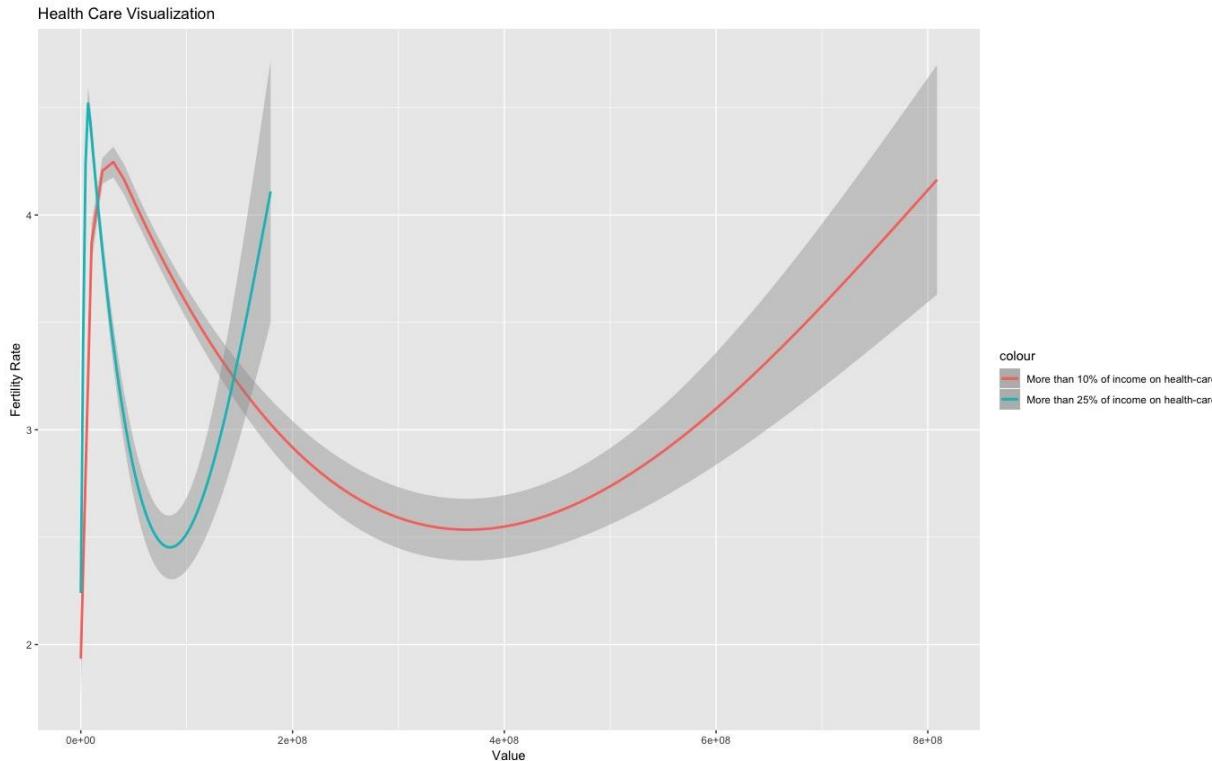
Health Care Model

Variable	Full Regression Model	Health Care Model 1	Health Care Model 2	Health Care Model 3
births_attended_by~t	-0.003*** (0.00)	-0.079*** (0.00)	-0.079*** (0.00)	
more_than_10%_inco~c	-0.000*** (0.00)	-0.000*** (0.00)	-0.000*** (0.00)	-0.000 (0.00)
more_than_25%_inco~c	0.000*** (0.00)	0.000*** (0.00)	0.000*** (0.00)	0.000 (0.00)
out_of_pocket_heal~e	-0.002*** (0.00)	-0.006*** (0.00)	0.029*** (0.00)	

Interesting Component to Health Care

- Deviation between two particular health-care variables:
 - Those who spend more than 10% of their income on health-care
 - Those who spend more than 25% of their income on health-care
- Spending more than 10% of income on health-care has a negative correlation with fertility rate
- Spending more than 25% of income on health-care has a positive correlation with fertility rate

Health Care Spending Visual



Why does this difference occur?

- Spending 10% of income on health-care:
 - In terms of developed countries, spending around 10% of income on health-care is considered to be “normal”
 - The average American, on average, spends 8% to 14% of their income on health-care
 - Considering this normalcy in developed countries, and the negative correlation between development and fertility rates, this explains the statistically significant negative correlation

Why this difference occurs? Continued

- Spending 25% on health-care:
 - Spending more than 25% of income on health-care usually would signify the existence of an underdeveloped country
 - Lower income level
 - Inefficient health-care system
 - Positive correlation between underdevelopment and fertility rate
 - A poor health-care system results in higher fertility rates
 - Parents have children to care for them when they become older

Female Labor Force

Female Labor Force Significance

Female Labor Force Model				
Variable	Full Regression Model	Female Labor Force Basic Education Model	Female Labor Force Intermediate Education Model	Female Labor Force Advanced Education Model
labor_force_participation_female	-0.003*** (0.00)			
female_labor_advanced_edu	0.041*** (0.00)	-0.211*** (0.00)		
female_labor_basic_edu	-0.003** (0.00)		-0.006*** (0.00)	
female_labor_intermediate_edu	0.016*** (0.00)			-0.176*** (0.00)

Labor Force Examination

- In the “Full Regression Model,” female labor force participation has a statistically significant negative correlation with fertility rate
- When regressed individually, each female labor force participation rate based upon educational attainment is also significantly negatively correlated with fertility rate
- Increase in education results in more opportunities in the labor market
 - Delays marriage
 - Reduces fertility due to age
 - Raising children at home is usually more time-intensive than working in the labor market
 - More education leads to higher wages
 - Women may feel that raising children is more expensive compared to the income forgone

Conclusion

Closing Thoughts

- With all things considered, it is understandable how economists view childbearing as an economic decision, where households decide between “consuming” children and goods
- As we have developed as a world, it is evident that the impact of this “decision” has spurred a negative correlation between income and fertility--naively hinting at this idea that children are inferior goods
- Our regression has tested this economic conundrum and has analyzed economic theories of quality/quantity model and income/development model

Closing Thoughts Continued

- Which suggest, without a quality dimension, from the perspective of standard consumer theory the lack of a strong income effect on fertility appears puzzling
- As we get richer, the price of our time and labor goes up
 - We "have to sacrifice more valuable labor time and more valuable education time in order to have kids"
- Our findings suggest that an increase in income is not the sole reason for a decrease in fertility rates but rather is a combination of many other factors
- With what our regression has showed us, and the projected world trends, we believe that the fertility rate worldwide will remain steady around 2

Summary

- Parents derive utility from both child quantity and the quality of children
- Labor force participation rate of women and their earnings increased significantly, contributed to a decline in fertility.
- Pronatalist policies encourage childbearing
- Antinatalist policies aim to reduce childbearing
- On average, the negative correlation between education and fertility rate holds true; however, we are beginning to see significant changes in this trend
- Across all three models, access to contraception of any method has a statistically significant negative correlation with fertility rate
- GDP per Capita, conceptually, is very similar to that of educational attainment
- Deviation between spending 10% or 25% of income on health-care
- Female labor force participation has a statistically significant negative correlation with fertility rate

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Thank You
