Higher population density is robustly associated with decreasing fertility rates over time: A 174-nation investigation

Online Supplementary Material

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Additional Analyses

Analyses with world region

We attempted to replicate this analysis when time was nested within country, which in turn was nested within the six world regions, however this analysis did not converge. Instead, we computed a similar model which only included the year and log of population density interaction. Although we cannot distinguish between within- and between-country change in this model, results were in the same direction, with fertility decreasing with density, b = -1.07, SE = 0.09, t(1977.16) = -11.53, $p < .001$, and where fertility decreased more over time in populations with higher densities, b = -0.06, SE = 0.001, t(11285.42) = -49.89, $p < .001$; model R^2_{Total} = .99.

Supplemental Tables

Table S1

Variables included in the present study, number of countries included for each variable, and the source of the data.

Variable	Variable description	Number of countries (years, if applicable)	Source
Fertility Rates	Fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years. Total fertility is calculated using age-specific fertility rates of the specified year.	174 (1950 – 2019)	Macrotrends (2020)
Population Density	Calculated using midyear population divided by land area in square kilometers. This variable was log transformed for analysis, due to high skewness and kurtosis.	174 (1950 – 2019)	Macrotrends (2020)
Gross Domestic Product (GDP)	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.	174 (1960 – 2019)	Macrotrends (2020)
Human Development Index (HDI)	HDI is a statistic composite of life expectancy, education, and per capita income indicators	160	Organisation for Economic Co-operation and Development (OECD) database (2020)
Inequality (Gini)	Inequality among household income values within a specified region	142	World Bank (2020)
Occupational Prestige	This data was originally coded by Integrated Public Use Microdata Series-International (IPUMS-I; Minnesota Population Center, 2015) into the major occupational categories. As in Santos, Varnum, and Grossmann (2017), we weighted these categories by multiplying the percentage of people in each category by a measure of popular evaluation of occupational standing obtained from the 1996 Standard International Occupational Prestige Scale.	39	Santos, Varnum, and Grossmann (2017)

	Higher scores refer to more people working at in higher prestige jobs.		
White-collar vs agricultural jobs	Santos, Varnum, and Grossmann (2017), used IPUMS-I data to calculate the percentage of people working as "skilled agricultural, forestry, and fishery workers" for agricultural jobs, and the percentage of people classified as "legislators, senior officials, and managers," "professionals," "technicians and associate professionals," "clerks," and "service workers and shop and market sales" as a proxy for white-collar jobs. Then, we subtracted the percentage of agricultural jobs from the percentage of white-collar jobs to create a measure where higher scores indicate a larger percentage of white-collar jobs.	39	Santos, Varnum, and Grossmann (2017)
Historical pathogen prevalence	Fincher, Thornhill, Murray, & Schaller (2008) estimated the prevalence pathogens detrimental to human reproductive fitness and coded the estimates on a points-based scale. They used historical sources for nine pathogens to create am estimate of pathogen prevalence.	89	Fincher, Thornhill, Murray, & Schaller (2008)
Contemporary pathogen prevalence	Fincher, Thornhill, Murray, & Schaller (2008) estimated the prevalence pathogens detrimental to human reproductive fitness and coded the estimates on a points-based scale. They used contemporary sources of 22 pathogens to create an estimate of pathogen prevalence.	94	Fincher, Thornhill, Murray, & Schaller (2008)
Climatic stress (temperature)	We obtained mean yearly temperature for each country from Statpedia (2020), which used data calculated by averaging the minimum and maximum daily temperatures in the country, averaged for the years 1961–1990. We took the absolute value of the difference between the annual mean and 22 °C as a measure of the deviation from the optimal temperature for humans to characterize climatic stress	162	Statpedia (2020)
Precipitation (yearly)	Average precipitation in depth (mm/year)	155	World Bank (2020)
Migration rates	Net migration rates are the differences between the number of people entering and leaving a country during the year, where higher numbers indicate greater migration	170	World Factbook database, through the Central Intelligence Agency
Sex ratio	Sex ratio is the number of males for each 100 females in a population, where numbers above 100 indicate there are more males than females in the population, and less than 100 indicates more females than males in a population.	174	World Bank (2020)

	Estimates were calculated based on the age/sex distributions of United Nations Population Division's World Population Prospects 2019 revision		
Population relatedness	Proportion of consanguineous marriages (i.e., those between persons genetically related as second cousins or closer)	66	Hoben, Buunk, Fincher, Thornhill, and Schaller (2010)
Religiosity	Joshanloo and Gebauer (2019) computed a religiosity index for 136 countries based on Gallup World Poll data, where participants answered the question “Is religion an important part of your daily life?”.	123	Joshanloo and Gebauer (2019)
Cultural tightness	Cultural tightness scale	57	(Gelfand et al., 2011)
Global gender-gap index	GGI is an index measure from 0 to 1 which characterizes national gender gaps on economic, education, health, and political criteria. Higher numbers indicate lower gender gaps.	136	Global Gender Gap Report 2020, created by the World Economic Forum
Gender-based educational attainment	This measure captures the gap between women 's and men 's current access to education through ratios of women to men in primary, secondary and tertiary-level education. The values range from 0 to 1, with one indicating that there is no gender-based gap in education	136	Global Gender Gap Report 2020, created by the World Economic Forum
Contraceptive use	Estimates of the prevalence of contraceptive use among women of reproductive age for 2019 for ‘any method’, which included the pill, injectables, implants, IUDs, male condoms, rhythm, withdrawal, and male or female sterilization.	160	United Nations Department of Economic and Social Affairs Contraceptive Use by Method booklet (2019)

Table S2

R Packages used for main text and supplementary analyses

Database/Package	Citation
R base program v3.3.1	R Core Team, 2016
broom v0.5.6	Robinson, 2014
caret v6.0-86	Kuhn, 2008
corrplot v0.84	Wei, Simko, Levy, Xie, Jin, & Zimla, 2017
countrycode v1.2.0	Arel-Bundock, Enevoldse, & Yetman, 2018
dplyr v1.0.0	Wickham, Francois, Henry, & Muller, 2019
forecast v8.12	Hyndman & Khandakar, 2007
ggeffects v0.15.0	Lüdecke, 2018
ggmap v3.0.0	Kahle & Wickham, 2013
ggplot2 v.3.3.2	Wickham, 2011
Hmisc v4.4-0	Harrel & Dupont, 2006
hts v6.0.0	Fenouil et al., 2016
jtools v.2.1.0	Long, 2020
lme4 v1.1-23	Bates, Mächler, Bolker, & Walker, 2015
lmerTest v3.1-2	Kuznetsova, Brockhoff, & Christensen, 2016
lmtest v0.9-37	Hothorn, Zeileis, Fareborother, Cummins, Millo, & Mitchell, 2019
lsr v0.5	Navarro, 2015
plyr v1.8.6	Wickham, Francois, Henry, & Muller, 2019
psych v1.9.12.31	Revelle, 2019
rworldmap v1.3-6	South, 2012
rworldxtra v1.01	South, 2012
tidyverse v1.3.0	Wickham et al., 2019

Table S3

Kendall's Tau correlations between population density and fertility, by country. We detrended the time series data by we residualizing out the effect of year on population density and fertility.

Country	Country Code	Kendall Tau correlation
Afghanistan	AFG	0.02
Albania	ALB	0.15
Algeria	DZA	-0.39
Angola	AGO	0.35
Antigua	ATG	-0.19
Argentina	ARG	-0.95
Armenia	ARM	-0.43
Aruba	ABW	0.09
Australia	AUS	-0.59
Austria	AUT	-0.78
Azerbaijan	AZE	0.18
Bahamas	BHS	-0.11
Bahrain	BHR	-0.73
Bangladesh	BGD	-0.28
Barbados	BRB	-0.14
Belarus	BLR	-0.87
Belgium	BEL	-0.84
Belize	BLZ	-0.58
Benin	BEN	0.16
Bhutan	BTN	0.19
Bolivia	BOL	-0.29
Botswana	BWA	-0.49
Brazil	BRA	-0.32
Bulgaria	BGR	-0.89
Burkina Faso	BFA	0.20
Burundi	BDI	0.52
Cabo-Verde	CPV	0.24
Cambodia	KHM	-0.06
Cameroon	CMR	0.42
Canada	CAN	-0.44
Central African Republic	CAF	0.53
Chad	TCD	0.73
Channel-Islands	CIS	-0.84
Chile	CHL	0.11
China	CHN	0.05
Colombia	COL	-0.39
Comoros	COM	-0.10

Costa Rica	CRI	-0.63
Croatia	HRV	-0.93
Cuba	CUB	0.04
Curacao	CUW	0.01
Cyprus	CYP	-0.63
Denmark	DNK	-0.79
Djibouti	DJI	0.11
Dominican Republic	DOM	-0.62
Ecuador	ECU	-0.75
Egypt	EGY	-0.52
El Salvador	SLV	0.42
Equatorial Guinea	GNQ	0.14
Estonia	EST	-0.90
Ethiopia	ETH	0.30
Fiji	FJI	-0.47
Finland	FIN	-0.75
France	FRA	-0.86
French Polynesia	PYF	-0.66
Gabon	GAB	0.27
Gambia	GMB	0.96
Georgia	GEO	-0.95
Germany	DEU	-0.87
Ghana	GHA	-0.13
Greece	GRC	-0.77
Grenada	GRD	0.54
Guam	GUM	-0.55
Guatemala	GTM	-0.41
Guinea	GIN	0.07
Guyana	GUY	0.23
Haiti	HTI	0.38
Honduras	HND	-0.69
Hong-Kong	HKG	-0.44
Hungary	HUN	-0.84
Iceland	ISL	-0.38
India	IND	-0.28
Indonesia	IDN	-0.32
Iran	IRN	-0.21
Iraq	IRQ	-0.33
Ireland	IRL	-0.37
Israel	ISR	0.78
Italy	ITA	-0.78
Jamaica	JAM	0.07
Japan	JPN	-0.86

Jordan	JOR	-0.55
Kazakhstan	KAZ	-0.21
Kenya	KEN	-0.49
Kiribati	KIR	0.13
Kuwait	KWT	-0.41
Latvia	LVA	-0.89
Lebanon	LBN	-0.16
Lesotho	LSO	0.21
Liberia	LBR	0.21
Libya	LBY	-0.31
Lithuania	LTU	-0.92
Luxembourg	LUX	-0.78
Macao	MAC	0.15
Macedonia	MKD	-0.06
Madagascar	MDG	-0.16
Malawi	MWI	0.24
Malaysia	MYS	-0.84
Maldives	MDV	-0.22
Mali	MLI	0.05
Malta	MLT	-0.39
Mauritania	MRT	0.60
Mauritius	MUS	0.05
Mexico	MEX	-0.38
Micronesia	FSM	-0.48
Moldova	MDA	-0.54
Mongolia	MNG	-0.09
Montenegro	MNE	-0.48
Morocco	MAR	-0.15
Mozambique	MOZ	0.72
Myanmar	MMR	0.18
Namibia	NAM	-0.06
Nepal	NPL	0.14
Netherlands	NLD	-0.60
New Caledonia	NCL	-0.47
New Zealand	NZL	-0.36
Nicaragua	NIC	-0.45
Niger	NER	0.95
Nigeria	NGA	0.92
Norway	NOR	-0.80
Oman	OMN	-0.11
Pakistan	PAK	0.04
Panama	PAN	-0.48
Papua New Guinea	PNG	-0.05

Paraguay	PRY	-0.51
Peru	PER	-0.44
Philippines	PHL	-0.73
Poland	POL	-0.59
Portugal	PRT	-0.53
Puerto Rico	PRI	0.02
Qatar	QAT	-0.61
Romania	ROU	-0.65
Russia	RUS	-0.78
Rwanda	RWA	-0.07
Samoa	WSM	0.62
Sao tome and Principe	STP	0.10
Saudi Arabia	SAU	-0.40
Senegal	SEN	0.17
Serbia	SRB	-0.89
Seychelles	SYC	0.19
Sierra leone	SLE	-0.11
Singapore	SGP	-0.03
Slovenia	SVN	-0.85
Solomon Islands	SLB	0.18
Somalia	SOM	0.60
South Africa	ZAF	-0.48
South Korea	KOR	0.07
Spain	ESP	-0.59
Sri Lanka	LKA	-0.09
Suriname	SUR	0.33
Swaziland	SWZ	-0.04
Sweden	SWE	-0.94
Switzerland	CHE	-0.83
Tajikistan	TJK	0.01
Tanzania	TZA	0.80
Thailand	THA	-0.20
Togo	TGO	-0.04
Tonga	TON	0.18
Trinidad-and-Tobago	TTO	0.34
Tunisia	TUN	-0.41
Turkey	TUR	-0.46
Turkmenistan	TKM	-0.34
Uganda	UGA	0.69
United Kingdom	GBR	-0.86
Ukraine	UKR	-0.80
United Arab Emirates	ARE	-0.73
Uruguay	URY	-0.98

United States	USA	-0.62
Uzbekistan	UZB	-0.30
Vanuatu	VUT	-0.49
Venezuela	VEN	-0.87
Vietnam	VNM	-0.12
Yemen	YEM	-0.37
Zambia	ZMB	0.22
Zimbabwe	ZWE	-0.25

Table S4

Results from MLM covariate analyses nested within countries. We investigated how between- and within-country change in population density influenced fertility rates.

Covariate Model	Variable	Est	*t*	*p*	R^2_M	ICC
Socio-Economic models						
Gross domestic product (GDP)	GDP	-0.28	-7.87	< .001	.31	.88
	Density (within)	-2.69	-17.89	< .001		
	Density (between)	-0.66	-3.77	< .001		
	Time	-0.01	-8.04	< .001		
	Time*Density (within)	-0.02	-6.71	< .001		
	Time*Density (between)	-0.004	-7.00	< .001		
Human development index (HDI)	HDI	-9.01	-19.11	< .001	.70	.66
	Density (within)	-0.91	-10.89	< .001		
	Density (between)	-0.11	-0.97	.333		
	Time	-1.02	-14.86	< .001		
	Time*Density (within)	-0.05	-28.44	< .001		
	Time*Density (between)	-0.01	-14.37	< .001		
Inequality (Gini)	Gini	0.09	4.93	< .001	.36	.86
	Density (within)	-0.88	-9.18	< .001		
	Density (between)	-0.26	-1.13	.260		
	Time	-0.02	-12.03	< .001		
	Time*Density (within)	-0.06	-27.35	< .001		
	Time*Density (between)	-0.01	-13.64	< .001		
Occupational prestige	Occupational prestige	-0.42	-5.58	< .001	.57	.80
	Density (within)	-3.70	-20.60	< .001		
	Density (between)	-0.04	-0.10	.923		
	Time	0.02	5.75	< .001		
	Time*Density (within)	-0.03	-8.89	< .001		
	Time*Density (between)	-0.02	-14.82	< .001		
White collar vs. agricultural jobs	Jobs	-2.74	-8.50	< .001	.71	.70

	Density (within)	-3.71	-20.32	< .001		
	Density (between)	-0.10	-0.31	.757		
	Time	0.02	5.74	< .001		
	Time*Density (within)	-0.03	-8.84	< .001		
	Time*Density (between)	-0.02	-14.92	< .001		
Geographic models						
Historical pathogen prevalence	Pathogens	1.75	10.80	< .001	.64	.74
	Density (within)	-2.46	-25.62	< .001		
	Density (between)	-0.40	-2.48	.015		
	Time	-0.01	-11.16	< .001		
	Time*Density (within)	-0.03	-14.44	< .001		
	Time*Density (between)	-0.005	-9.51	< .001		
Contemporary pathogen prevalence	Pathogens	0.17	-25.27	< .001	.62	.76
	Density (within)	-2.26	-25.27	< .001		
	Density (between)	0.08	0.49	.626		
	Time	-0.02	-13.46	< .001		
	Time*Density (within)	-0.03	-14.54	< .001		
	Time*Density (between)	-0.005	-10.01	< .001		
Climatic stress	Climatic Stress	-0.18	-10.66	< .001	.53	.78
	Density (within)	-0.88	-11.12	< .001		
	Density (between)	-0.53	-3.41	.001		
	Time	-0.02	13.87	< .001		
	Time*Density (within)	-0.05	-27.80	< .001		
	Time*Density (between)	-0.01	-16.76	< .001		
Precipitation	Precipitation	0.00	0.96	.337	.29	.86
	Density (within)	-0.87	-10.71	< .001		
	Density (between)	-0.57	-2.72	.007		
	Time	-0.01	-12.07	< .001		
	Time*Density (within)	-0.05	-29.26	< .001		
	Time*Density (between)	-0.01	-16.85	< .001		
Population characteristics						
Migration rates	Migration rates	-0.003	-0.69	.488	.31	.86

	Density (within)	-0.96	-12.18	< .001		
	Density (between)	-0.52	-2.81	.006		
	Time	-0.02	-14.00	< .001		
	Time*Density (within)	-0.05	-27.38	< .001		
	Time*Density (between)	-0.01	-18.48	< .001		
Sex ratio	Sex Ratio	0.01	1.50	.135	.32	.85
	Density (within)	-0.98	-12.66	< .001		
	Density (between)	-0.56	-3.13	.002		
	Time	-0.02	-16.07	< .001		
	Time*Density (within)	-0.05	-26.72	< .001		
	Time*Density (between)	-0.01	-17.37	< .001		
Relatedness	Relatedness	0.06	9.10	< .001	.66	.70
	Density (within)	-1.72	-16.08	< .001		
	Density (between)	-0.32	-1.57	.121		
	Time	-0.02	-13.00	< .001		
	Time*Density (within)	-0.04	-16.13	< .001		
	Time*Density (between)	-0.004	-5.37	< .001		
Cultural models						
Religiosity	Religiosity	5.35	15.15	< .001	.67	.71
	Density (within)	-1.60	-14.78	< .001		
	Density (between)	-0.20	-1.40	.163		
	Time	-0.003	-2.82	.001		
	Time*Density (within)	-0.05	-21.08	< .001		
	Time*Density (between)	-0.01	-19.88	< .001		
Cultural Tightness	Tightness	2.12	5.90	< .001	.56	.76
	Density (within)	-3.21	-23.44	< .001		
	Density (between)	-0.37	-1.51	.137		
	Time	-0.01	-7.74	< .001		
	Time*Density (within)	-0.02	-5.64	< .001		
	Time*Density (between)	-0.01	-7.47	< .001		
Female status/empowerment models						

Gender-gap index (GGI)	GGI	-15.50	-7.86	< .001	.46	.82
	Density (within)	-1.37	-16.28	< .001		
	Density (between)	-0.41	-2.10	.038		
	Time	-0.01	-11.66	< .001		
	Time*Density (within)	-0.05	-25.18	< .001		
	Time*Density (between)	-0.01	-12.83	< .001		
Educational attainment (gender gap)	Educational attainment	-14.10	-8.86	< .001	.51	.81
	Density (within)	-1.31	-15.56	< .001		
	Density (between)	-0.25	-1.32	.188		
	Time	-0.01	-12.61	< .001		
	Time*Density (within)	-0.05	-25.64	< .001		
	Time*Density (between)	-0.01	-12.59	< .001		
Contraceptive use	Contraceptives	-0.07	-12.07	< .001	.59	.75
	Density (within)	-0.88	-11.06	< .001		
	Density (between)	-0.20	-1.39	.167		
	Time	-0.01	-12.29	< .001		
	Time*Density (within)	-0.05	-28.00	< .001		
	Time*Density (between)	-0.01	-20.96	< .001		

Table S5

Results from MLM covariate analyses nested within countries using detrended population density and fertility data (i.e., time was residualized out). Population density was a significant negative predictor of fertility rates in all models.

Covariate Model	Variable	Est	*t*	*p*	R^2_M	ICC
Overall model						
Population density	Density	-2.04	-37.37	< .001	.35	.87
Socio-Economic models						
Gross domestic product (GDP)	Density	-3.04	-36.13	< .001	.47	.93
	GDP	-0.22	-6.41	< .001		
Human development index (HDI)	Density	-2.08	-35.29	< .001	.60	.81
	HDI	-7.39	-10.41	< .001		
Inequality (Gini)	Density	-2.20	-31.77	< .001	.37	.88
	Gini	0.04	2.32	.022		
Inequality + GDP	Density	-3.15	-31.04	< .001	.44	.93
	Gini	0.02	1.10	.274		
	GDP	-0.18	-4.47	< .001		
Occupational prestige	Density	-3.57	-24.51	< .001	.52	.89
	Prestige	-0.35	-2.84	.008		
White collar vs. agricultural jobs	Density	-3.54	-24.42	< .001	.59	.87
	Jobs	-2.50	-4.30	< .001		
Geographic models						
Historical pathogen prevalence	Density	-3.15	-48.00	< .001	.57	.91
	Pathogens	1.86	5.89	< .001		
Contemporary pathogen prevalence	Density	-2.96	-49.07	< .001	.51	.92
	Pathogens	0.09	2.74	.007		
Climatic stress	Density	-2.02	-36.45	< .001	.51	.82
	Climate stress	-0.17	-8.84	< .001		

Climatic stress + historical pathogens	Density	-3.17	-47.97	< .001	.58	.90
	Climate stress	-0.10	-2.16	.034		
	Pathogens	1.12	2.48	.015		
Climatic stress + GDP	Density	-3.00	-35.46	< .001	.55	.91
	Climate stress	-0.17	-6.90	< .001		
	GDP	-0.19	-5.21	< .001		
Precipitation	Density	-2.16	-37.40	< .001	.34	.87
	Precipitation	< .001	2.07	.040		
Population characteristics						
Migration rates	Density	-2.04	-36.93	< .004	.34	.87
	Migration	-0.004	-0.84	.403		
Sex ratio	Density	-2.04	-37.36	< .001	.36	.87
	Sex ratio	0.003	0.66	.511		
Relatedness	Density	-2.81	-36.48	< .001	.54	.87
	Relatedness	0.05	4.29	< .001		
Cultural models						
Religiosity	Density	-2.59	-34.49	< .001	.60	.86
	Religiosity	4.47	7.76	< .001		
Cultural Tightness	Density	-3.29	-37.82	< .001	.53	.92
	Tightness	2.50	3.70	.001		
Religiosity + Tightness	Density	-3.81	-36.86	< .001	.54	.94
	Religiosity	2.62	1.68	.102		
	Tightness	2.49	2.58	.014		
Female status/empowerment models						
Gender-gap index (GGI)	Density	-2.59	-43.84	< .001	.48	.88
	GGI	-13.68	-5.36	< .001		
Gender-gap index + GDP	Density	-3.84	-41.03	< .001	.52	.94
	GGI	-12.95	-3.88	< .001		
	GDP	-0.25	-3.12	< .001		

	Educational attainment gender gap	Density	-2.55	-42.95	< .001	.49	.88
		Education	-10.91	-5.13	< .001		
	Contraceptive use	Density	-1.92	-34.47	< .001	.53	.81
		Contraceptives	-0.06	-8.03	< .001		

Table S6

Results from MLM moderator analyses nested within countries using detrended within-country change in population density and fertility data (i.e., time was residualized out), investigating the interaction between each moderator and density.

Covariate Model	Variable	Est	*t*	*p*	R^2_M	ICC
Socio-Economic models						
Gross domestic product (GDP)	Density	5.67	17.48	< .001	.52	.70
	GDP	-0.01	-0.05	.961		
	Density*GDP	-2.08	-24.35	< .001		
Human development index (HDI)	Density	10.22	33.13	< .001	.63	.65
	HDI	7.97	13.25	< .001		
	Density*HDI	-16.93	-41.35	< .001		
Inequality (Gini)	Density	-8.63	-23.36	< .001	.18	.84
	Gini	-0.08	-4.43	< .001		
	Density*Gini	0.18	17.36	<.001		
Occupational prestige	Density	-3.73	-1.48	.138	.38	.78
	Prestige	-0.42	-4.07	< .001		
	Density* Prestige	-0.002	-0.04	.972		
White collar vs. agricultural jobs	Density	-1.78	-9.66	< .001	.58	.71
	Jobs	3.29	6.92	< .001		
	Density*Jobs	-6.02	-17.59	< .001		
Geographic models						
Historical pathogen prevalence	Density	-2.88	-39.78	< .001	.49	.74
	Pathogens	-0.20	-0.98	.330		
	Density* Pathogens	1.86	14.33	< .001		
Contemporary pathogen prevalence	Density	-5.93	-15.31	< .001	.49	.73
	Pathogens	0.06	3.10	.002		
	Density*	0.10	7.63	< .001		

	Pathogens					
Climatic stress	Density	-0.35	-3.57	< .001	.33	.86
	Climate stress	0.07	3.45	.001		
	Density* Climatic Stress	-0.24	-22.33	< .001		
Precipitation	Density	-2.29	-28.03	< .001	.02	.85
	Precipitation	< -0.00	-0.22	.824		
	Density* Precipitation	< 0.00	0.96	.336		
Population characteristics						
Migration rates	Density	-2.05	-34.84	< .001	.02	.85
	Migration	0.07	6.48	< .001		
	Density* Migration	-0.07	-7.42	< .001		
Sex ratio	Density	-2.22	-19.69	< .001	.02	.85
	Sex ratio	0.005	1.16	.249		
	Density* Sex ratio	< 0.00	0.75	.452		
Relatedness	Density	-5.12	-33.68	< .001	.48	.70
	Relatedness	-0.01	-1.29	.201		
	Density* Relatedness	0.07	16.12	< .001		
Cultural models						
Religiosity	Density	-7.12	-40.94	< .001	.58	.72
	Religiosity	-2.93	-6.37	< .001		
	Density* Religiosity	8.24	28.37	< .001		
Cultural Tightness	Density	-3.78	-40.90	< .001	.36	.77
	Tightness	0.15	0.38	.708		
	Density* Tightness	1.82	11.37	< .001		
Female status/empowerment models						
Gender-gap index (GGI)	Density	9.13	13.42	< .001	.28	.81
	GGI	2.47	1.12	.264		

	Density*GGI	-17.43	-17.46	< .001		
Educational attainment gender gap	Density	31.76	29.49	< .001	.37	.80
	Education	20.90	11.19	< .001		
	Density* Education	-35.21	-32.00	< .001		
Contraceptive use	Density	3.06	19.50	< .001	.45	.75
	Contraceptives	0.06	8.40	< .001		
	Density* Contraceptives	-0.13	-35.06	< .001		

Supplemental Figures

Figure S1

Kendall's Tau correlations among variables

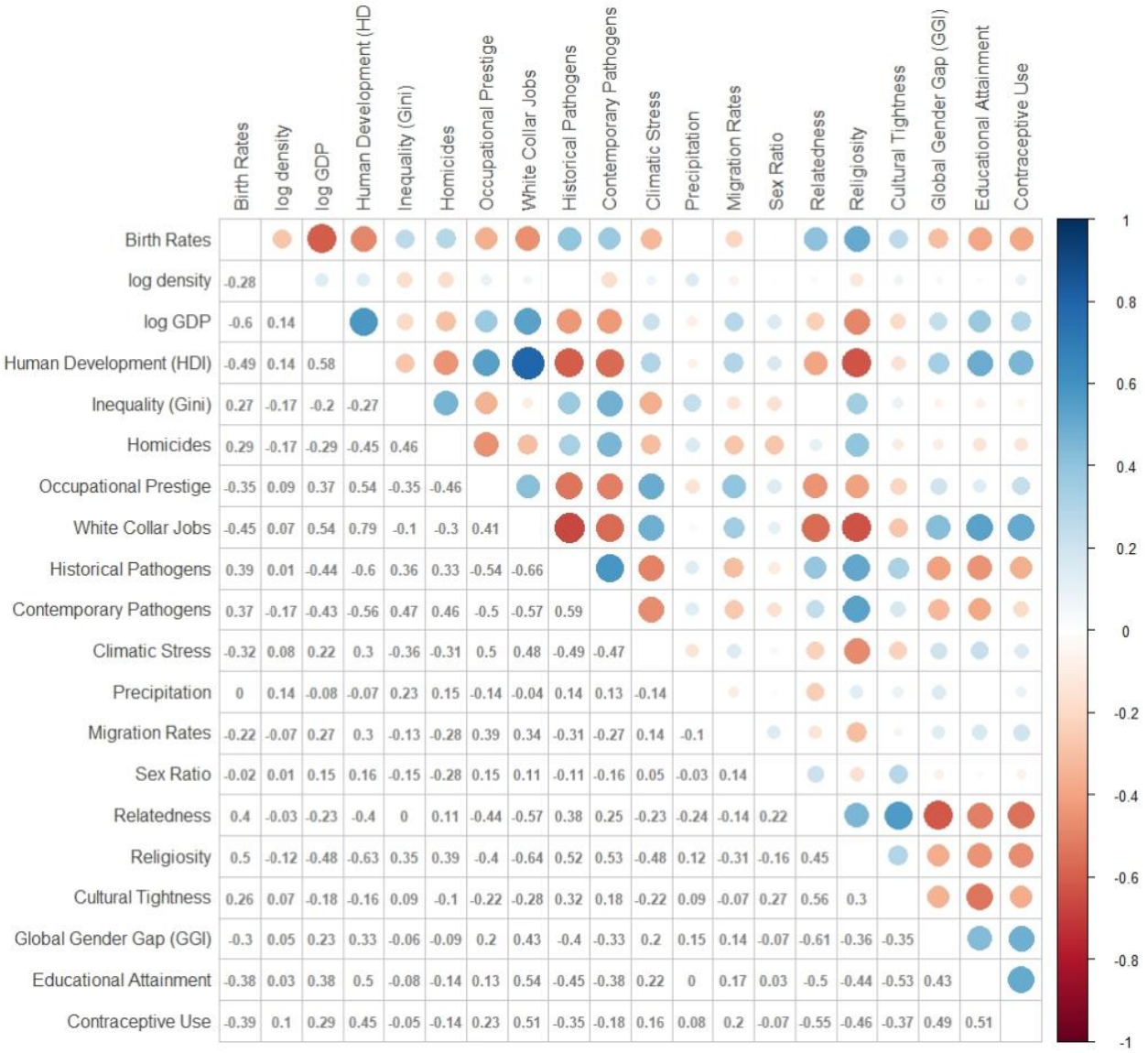
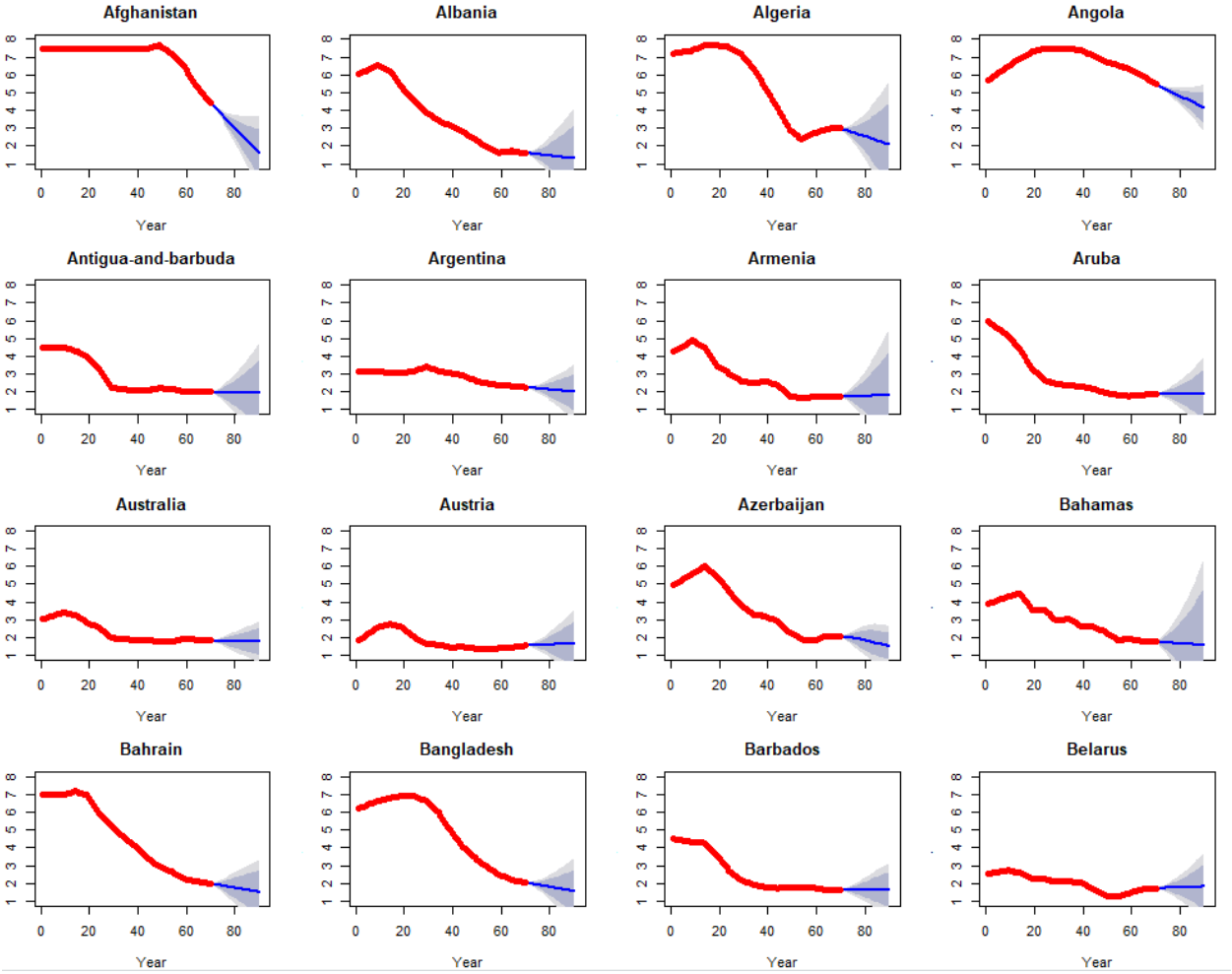
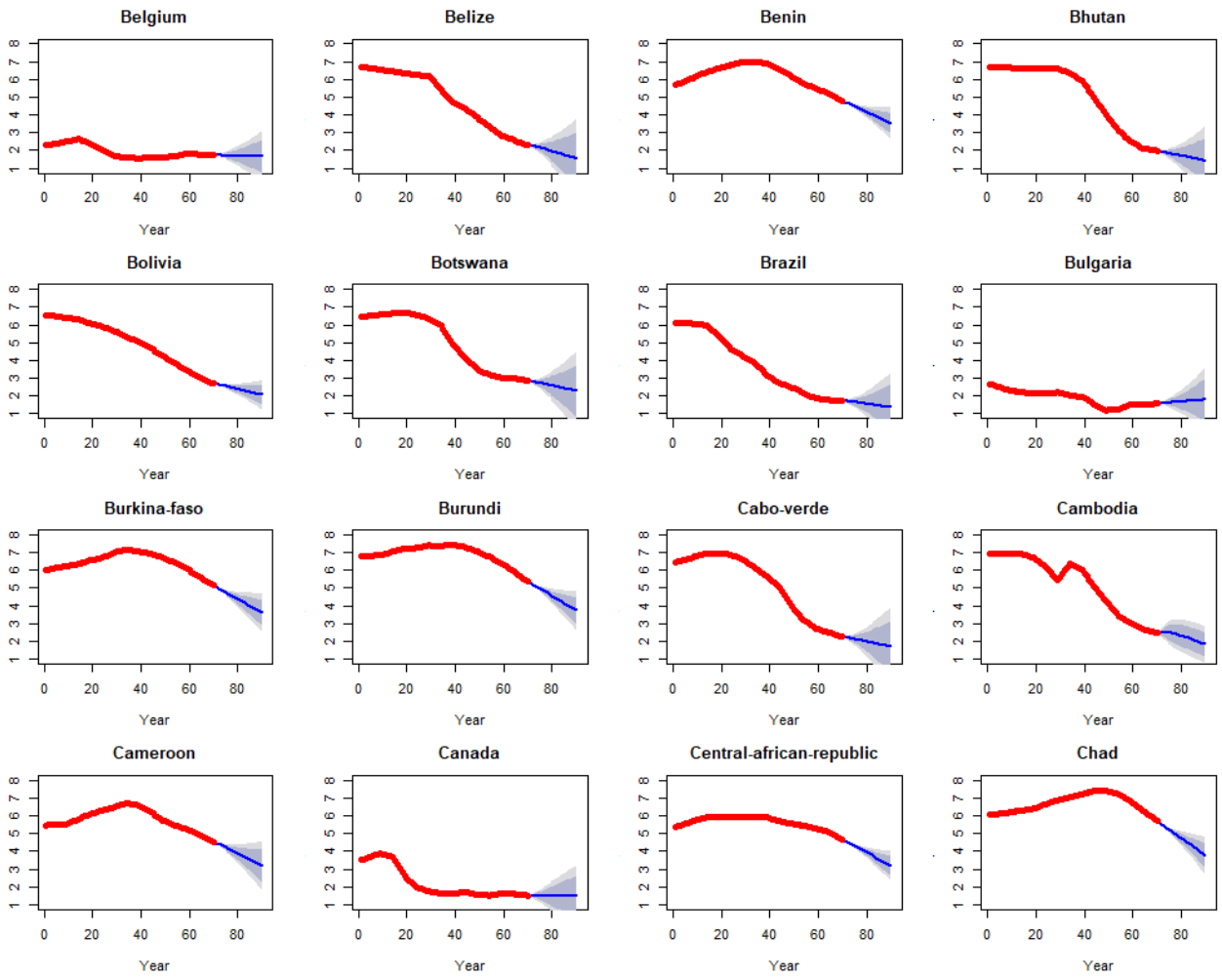


Figure S2

Fertility forecasts over time accounting for population density (log transformed), by country. Data is plotted from 1950 to 2019 (Year 0 to 60, in red). Forecasts start at 2020 (year 70) for 20 years (until 2040, year 90).

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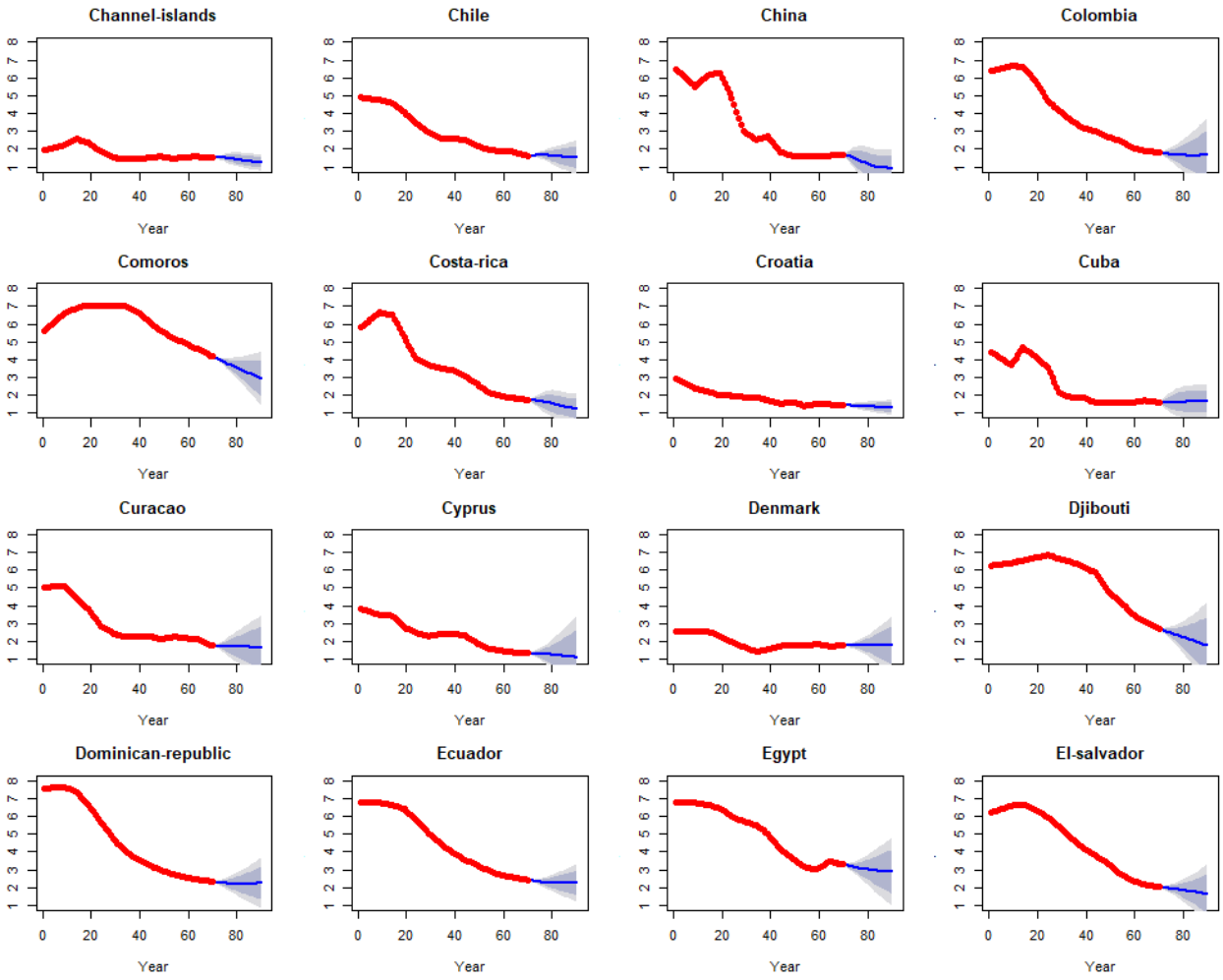
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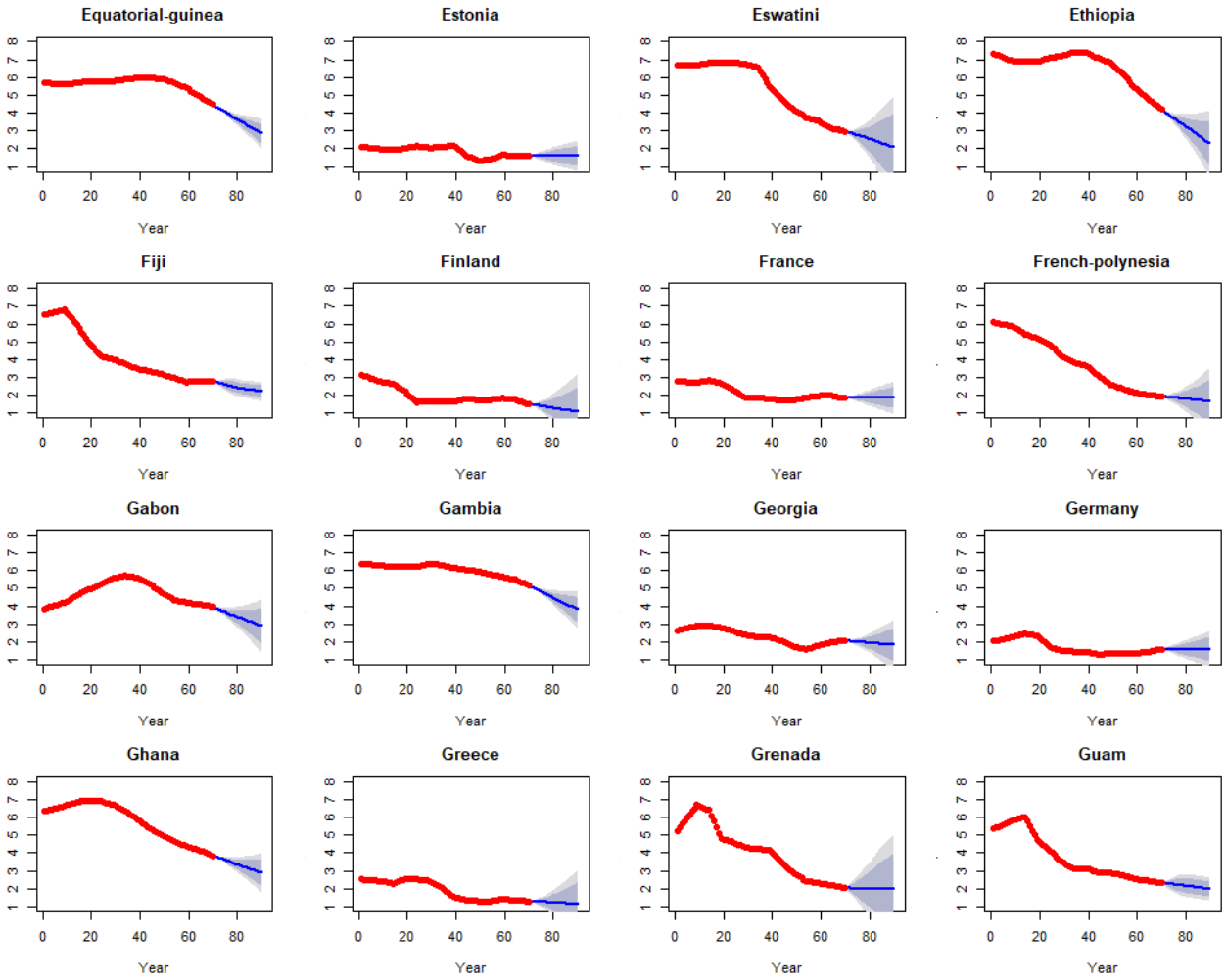
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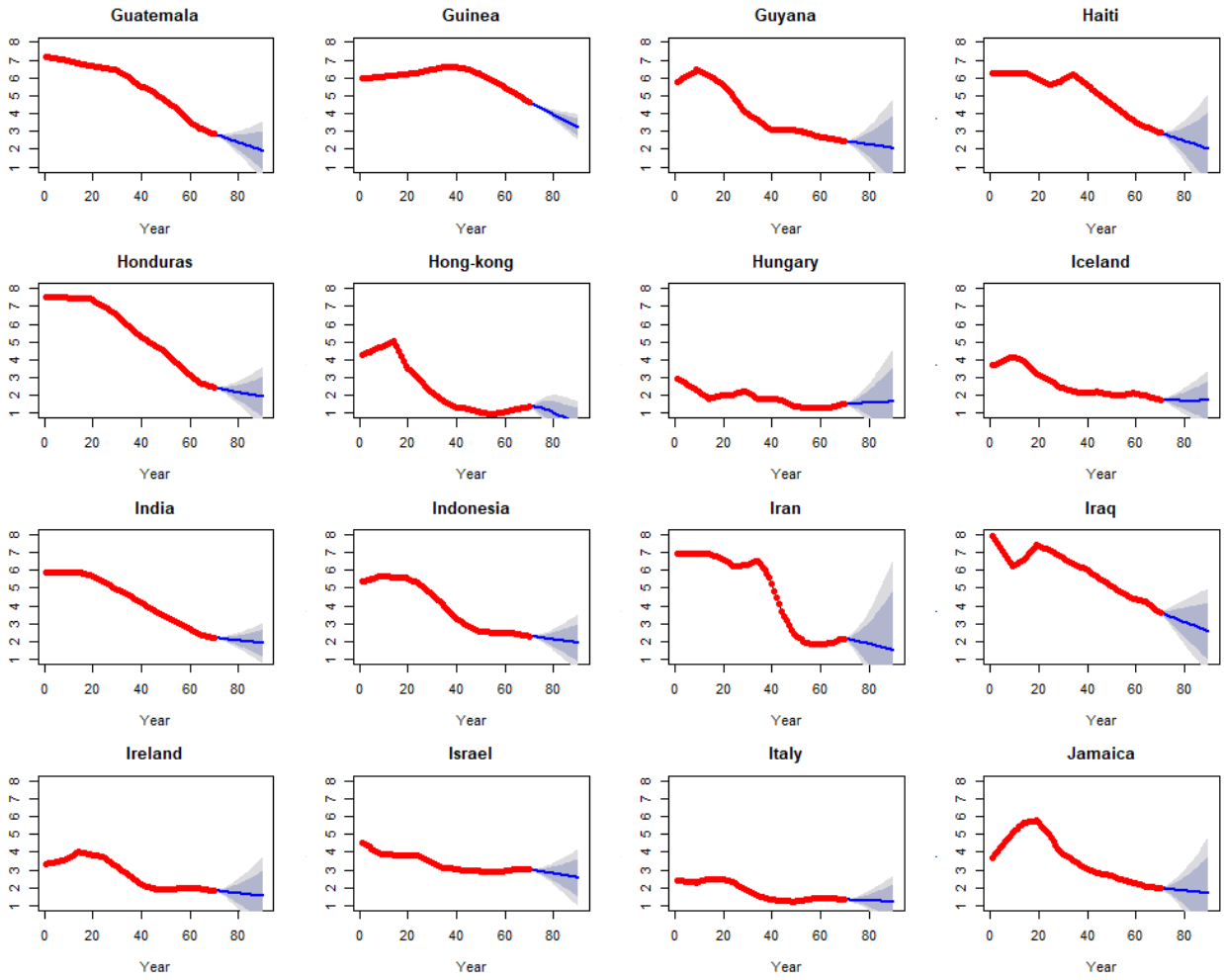
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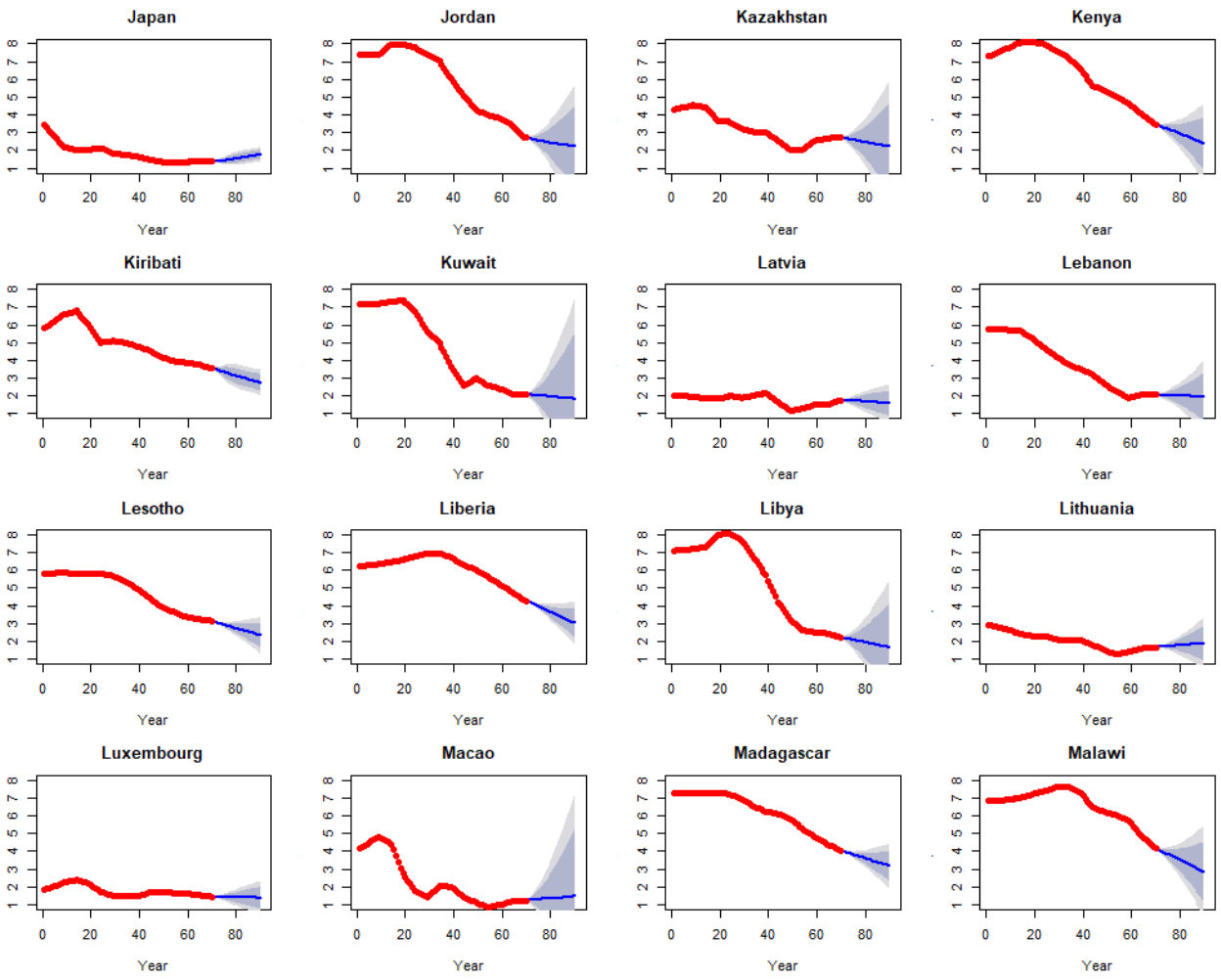
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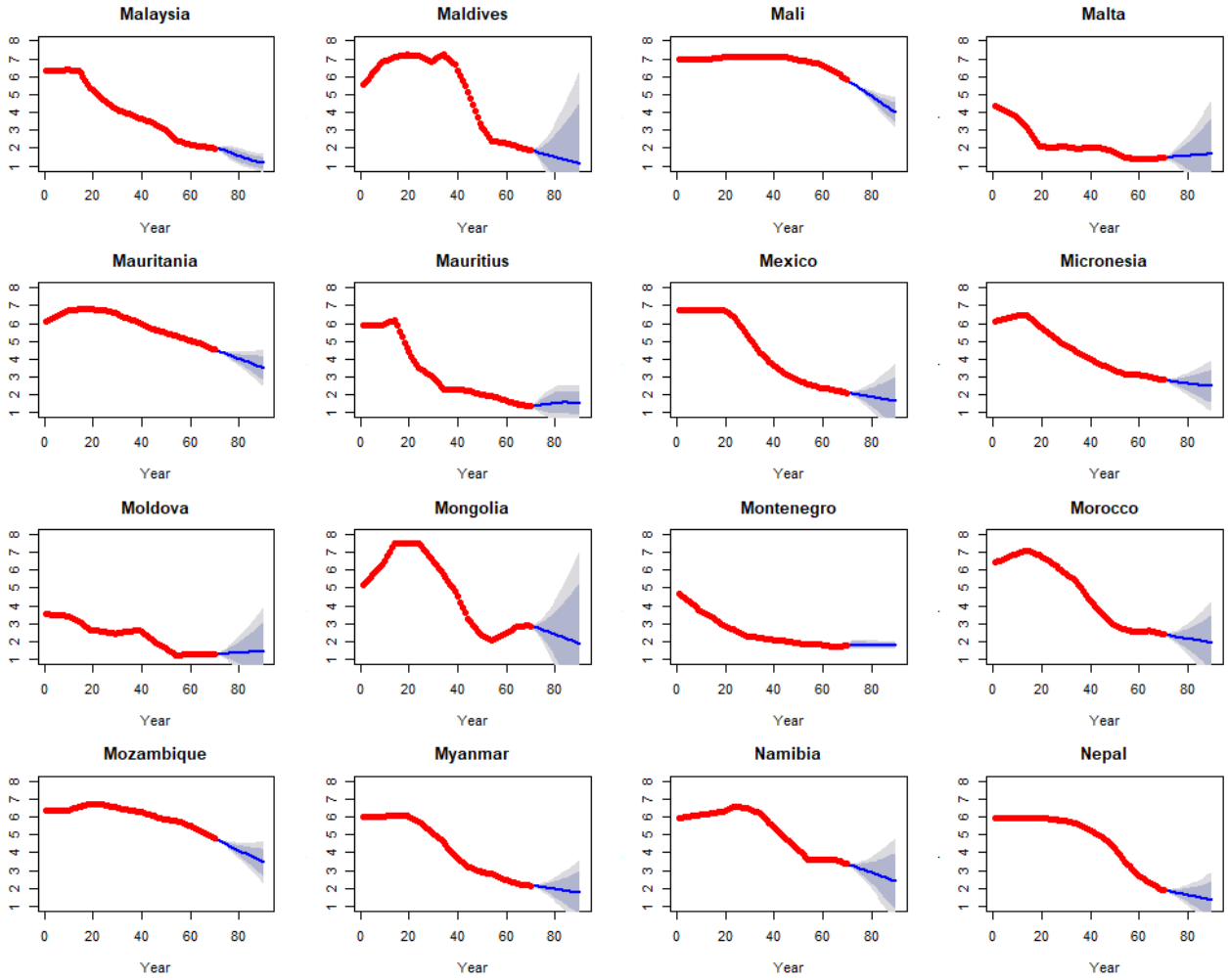
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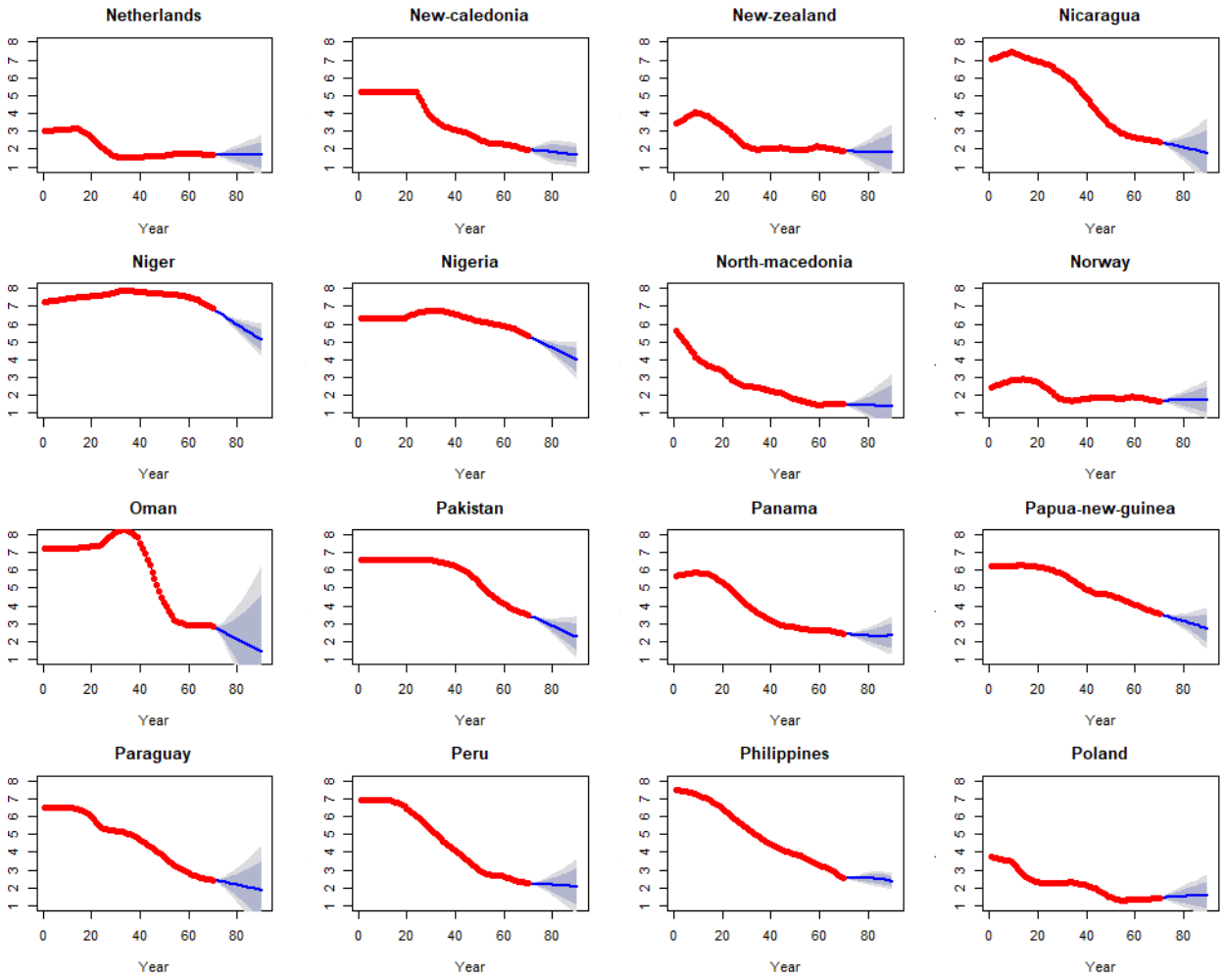
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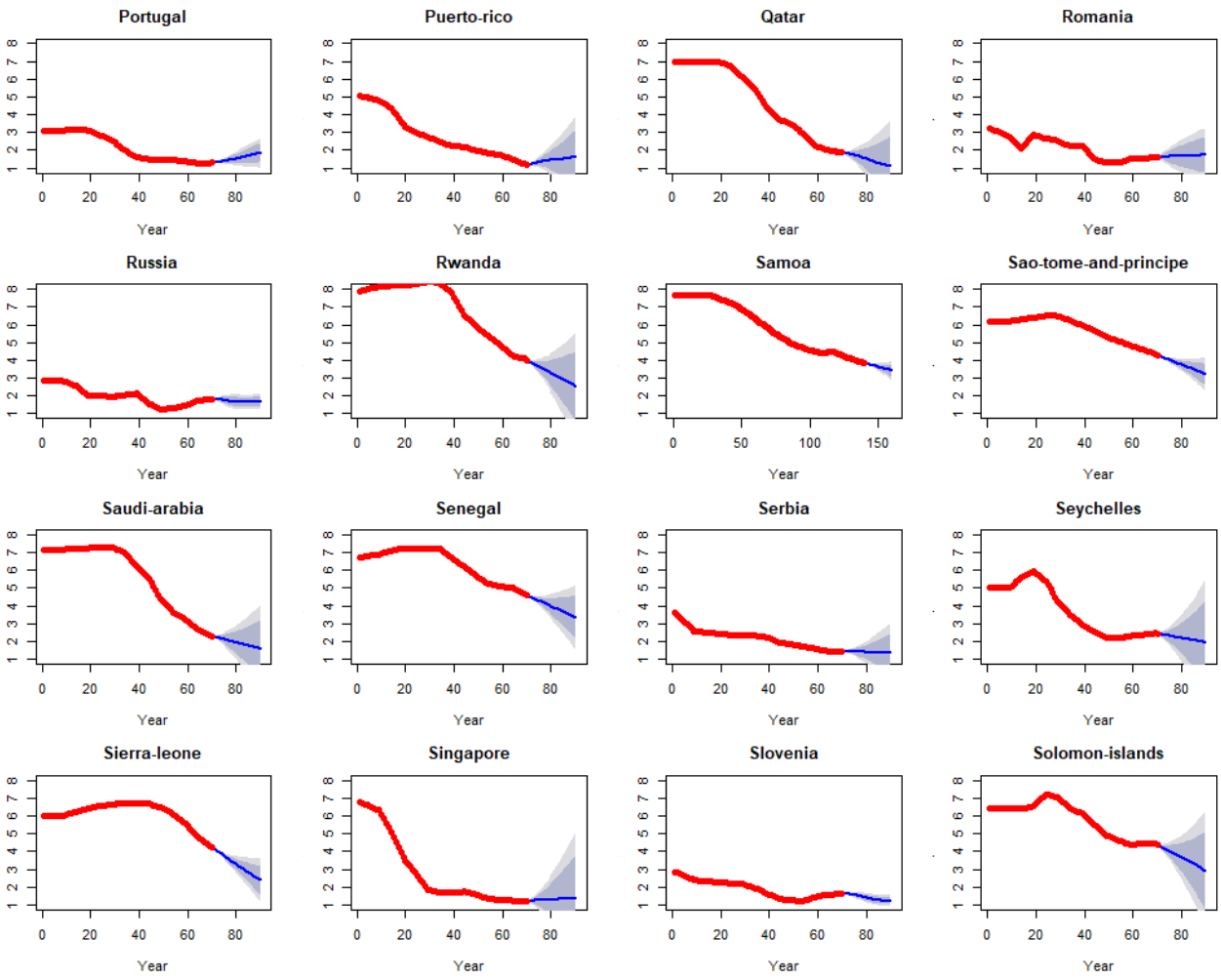
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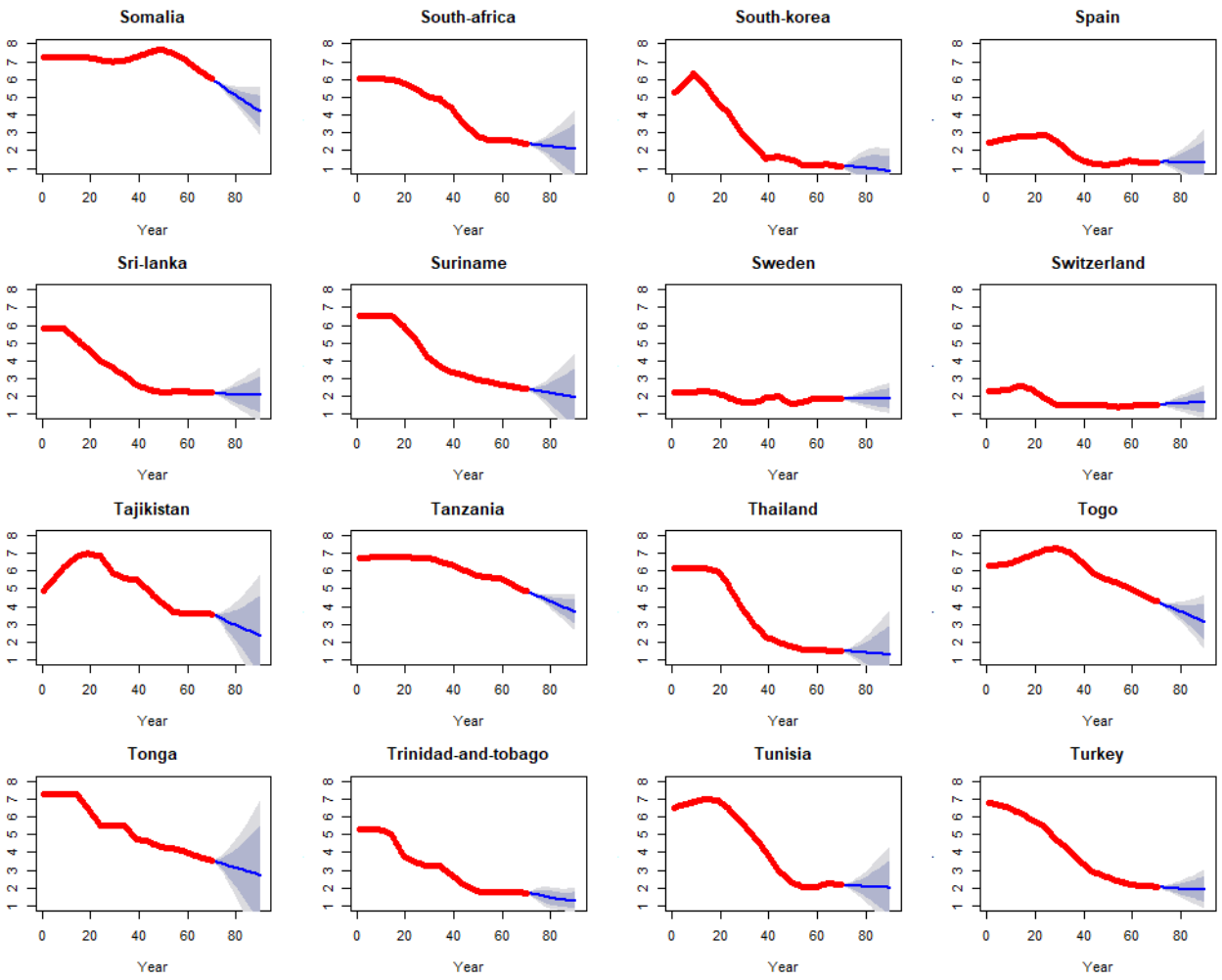
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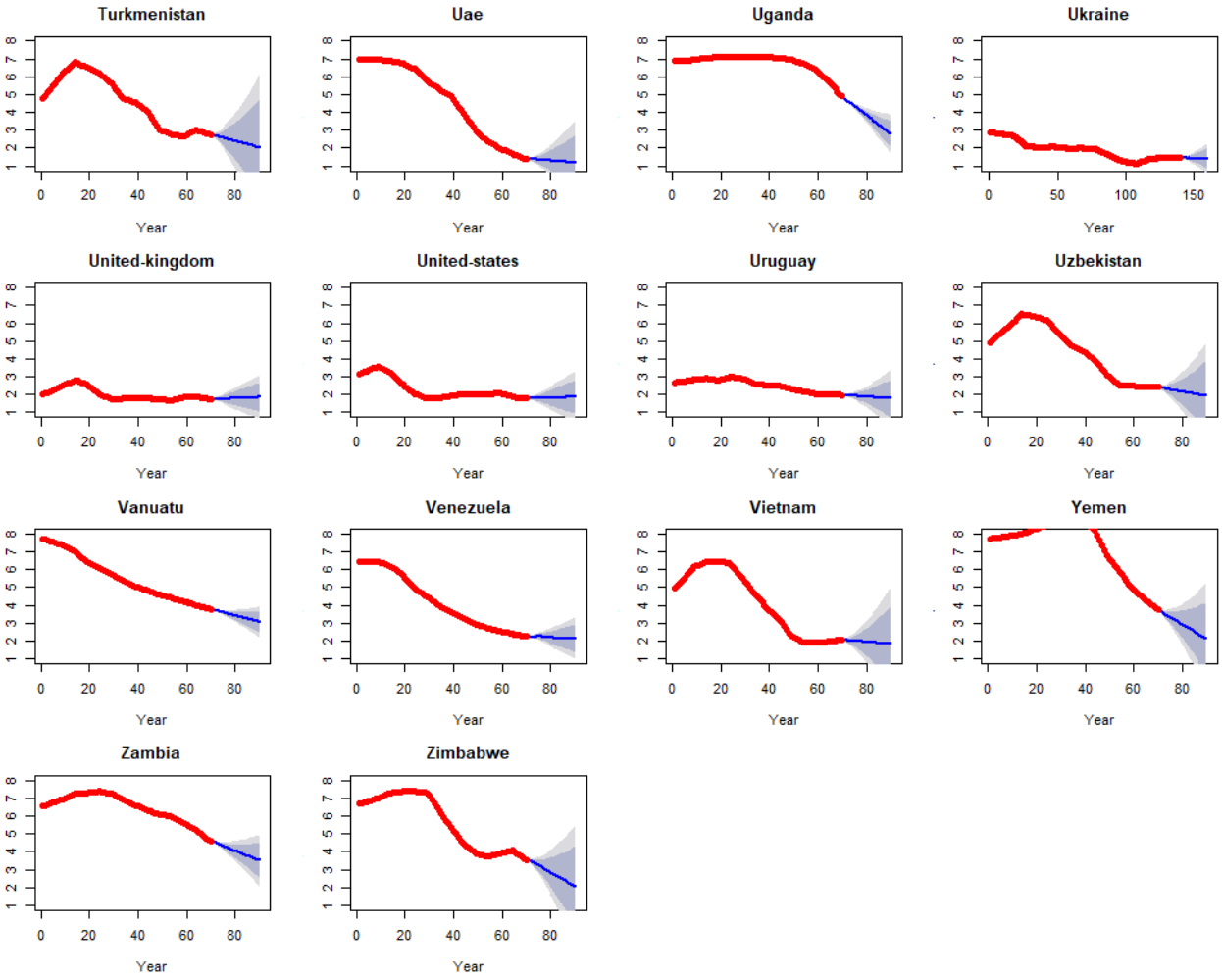
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