Global Fertility Rate and Population Growth Rate

An analysis from 1951 to 2020

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Inquiry

This paper will analyze the statistical relationship between the global fertility rate and the global population growth rate from 1951 to 2020.

Data Introduction

- Global fertility rate (flow variable)

The global fertility rate is the average number of children that a woman would give birth to, assuming age-specific fertility rates throughout a woman's lifetime. This variable can be represented mathematically as $\frac{a}{b} \cdot (100)$, where *a* is the number of children and *b* represents the number of women of childbearing age in that particular year.

- Global population growth rate (flow variable)

The global population growth rate is the increase in world population expressed as a percentage, usually measured on a year-to-year basis. This is expressed mathematically as $\frac{(a-b)}{b} \cdot (100)$, where *a* is the population in the current year, and *b* is the population in the previous year or $ln(a) - ln(b)$ for smaller growth rates, of which population growth usually is.

We collected the data for both variables from the United Nations Department of Economic and Social Affairs, Population Division (2019). World Population Prospects: The 2019 Revision. The data covers the years 1951 - 2020, with each variable measured every year.

Independent Statistical Analysis

Below is a chart summarizing the results from our data.

Table 1

	Global Fertility Rate, 1951-2020 (births per woman)	Global Population Growth Rate, 1951-2020 (per year)
Mean	3.656	0.016
Variance	0.995	0.000
Standard deviation	0.997	0.003
Standard error	0.118	0.000
Minimum	2.442	0.0105
Maximum	5.024	0.0209
Range	2.608	0.010
Skewness	0.224	-0.269

Before comparing these numbers, it is crucial to recognize that the replacement fertility rate—the number of children per woman needed to maintain a steady population size—is 2.1 births per woman.[1] The growth rate of a theoretical population with a replacement rate of 2.1 would be zero while holding external factors, such as mortality rate, as fixed. With that background in place, we can compare the two variables. The mean of the fertility rate was 3.656 children per woman, while the mean population growth rate was 0.016 (or 1.6% as a percentage) per year.

This is intriguing because the mean fertility rate of 3.656 is much larger than 1.6% above the replacement fertility rate—that would be 2.116. Indeed, it is 74% higher than the replacement fertility rate.[2]

[1] Craig J. (1994). Replacement level fertility and future population growth. Population trends, (78), 20–22.
[2] Obtained by dividing the mean fertility rate (3.656) by the replacement rate (2.1).

The variance (0.995) and standard deviation (0.997) of the global fertility rate indicate that the spread of the fertility rate from the mean value is close to 1, which is a moderate amount of spread. As for the global population growth rate, the variance (0.000) and standard deviation (0.004) show very little spread from year to year. The standard error for the global fertility rate and global population growth rate are 0.118 and 0.000, respectively, indicating that the sample means are very close to the real population mean.

The minimum value for fertility rate was 2.442 in 2020, which seems to be mostly a continuation of the natural decline in fertility rates over time rather than a consequence of the global unrest associated with COVID-19. If there is a relationship, it is beyond the scope of our paper. The maximum value for the fertility rate was 5.024, in 1951. For the global population growth rate, the minimum value was 0.0105 (1.05%) and the maximum value was 0.0209 (2.09%).

Since the skewness for the fertility rate is 0.2237, the data are slightly skewed right (forward in time) compared to a normal distribution. The skewness for the global population growth rate is -0.269, so the data are slightly skewed left (back in time) relative to a normal distribution.

Related Statistics

Table 2

Covariance	Correlation
0.00283	0.892

From Table 2, the covariance between the global fertility rate and the global population growth rate is 0.00283, with a corresponding correlation of 0.892. This correlation suggests a significant positive relationship between the global fertility rate and the global population growth rate. That means that as the global fertility rate increases, the global population growth rate tends to increase as well, and as the global fertility rate decreases, the global population rate tends to decrease as well.

Both variables measure similar metrics. They are positively influenced by the birth rate (how many new people are born) and negatively influenced by the mortality rate (how many people die). These, in turn, have been strongly affected by factors leading to more economic growth. Now we will look at each variable in turn.

A major factor affecting fertility rates is educational attainment, especially in women. This has lowered fertility rates by opening up more opportunities for women, including employment options. This has led to a cultural shift towards smaller family sizes. Other variables that Roser discusses affecting fertility rate include better access to contraception and family planning.[3]

[3] Roser, M. (2014, February 19). *Fertility Rate*. Our World in Data. Retrieved November 17, 2021, from https://ourworldindata.org/fertility-rate.

The global population growth rate is similar to the fertility rate in some ways, but it also includes the effects of mortality rate and of life expectancy. Since both of these have been greatly reduced from 1951 to 2020 due to economic growth, increasing global prosperity, and many other factors, the global population growth rate has not tracked fertility rates as much as one would expect. That said, the fertility rate may not simply go down with higher economic growth. There may be evidence that fertility rates once again climb at very high levels of economic development.[4]

Conclusion

This paper analyzed the relationship between the global fertility rate and the global population growth rate from 1951 - 2020. Our results showed that these two variables have a strong correlation. We then discussed literature that has investigated external factors affecting both variables, including economic growth and its antecedents. Our data did not include population data for 1949, and thus this analysis excludes 1950 in our summary statistics. Other external variables can and in theory do have a lot of influence on both variables. Future research could investigate the effects of different social and economic factors on fertility rates and population growth rates for countries or world regions.

[4] Roser, M. (2014, February 19). *Fertility Rate*. Our World in Data. Retrieved November 17, 2021, from https://ourworldindata.org/fertility-rate.

Appendix

Appendix A: Works Cited

Craig J. (1994). Replacement level fertility and future population growth. Population trends, (78), 20–22.

Roser, M. (2014). *Women's educational attainment vs. number of children per woman*. Our World in Data. Accessed September 27, 2021, https://ourworldindata.org/grapher/womens-educational-attainment-vs-fertility

Roser, M. (2014, February 19). *Fertility Rate*. Our World in Data. Retrieved November 17, 2021, from https://ourworldindata.org/fertility-rate.

Appendix B: Data

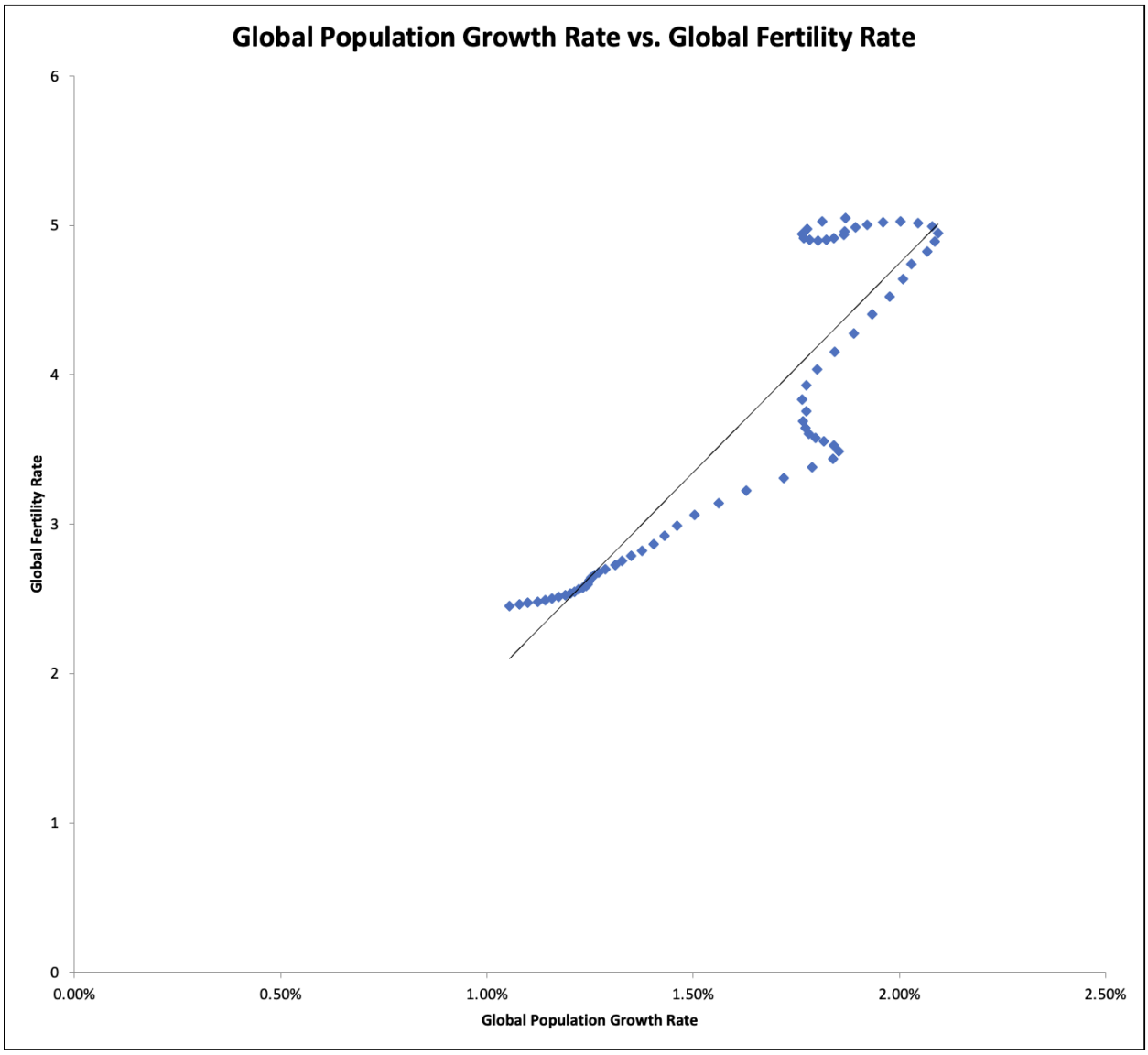
Year	Estimates, 1950 - 2020: Annually interpolated demographic indicators - Total fertility (live births per woman)	Total population (Gapminder, HYDE & UN)	Growth rate of Population
1950 (not included)	*5.05*	*2536605808*	*N/A*
1951	5.024	2584034223	1.87%
1952	4.977	2630861688	1.81%
1953	4.941	2677609059	1.78%
1954	4.916	2724846751	1.76%

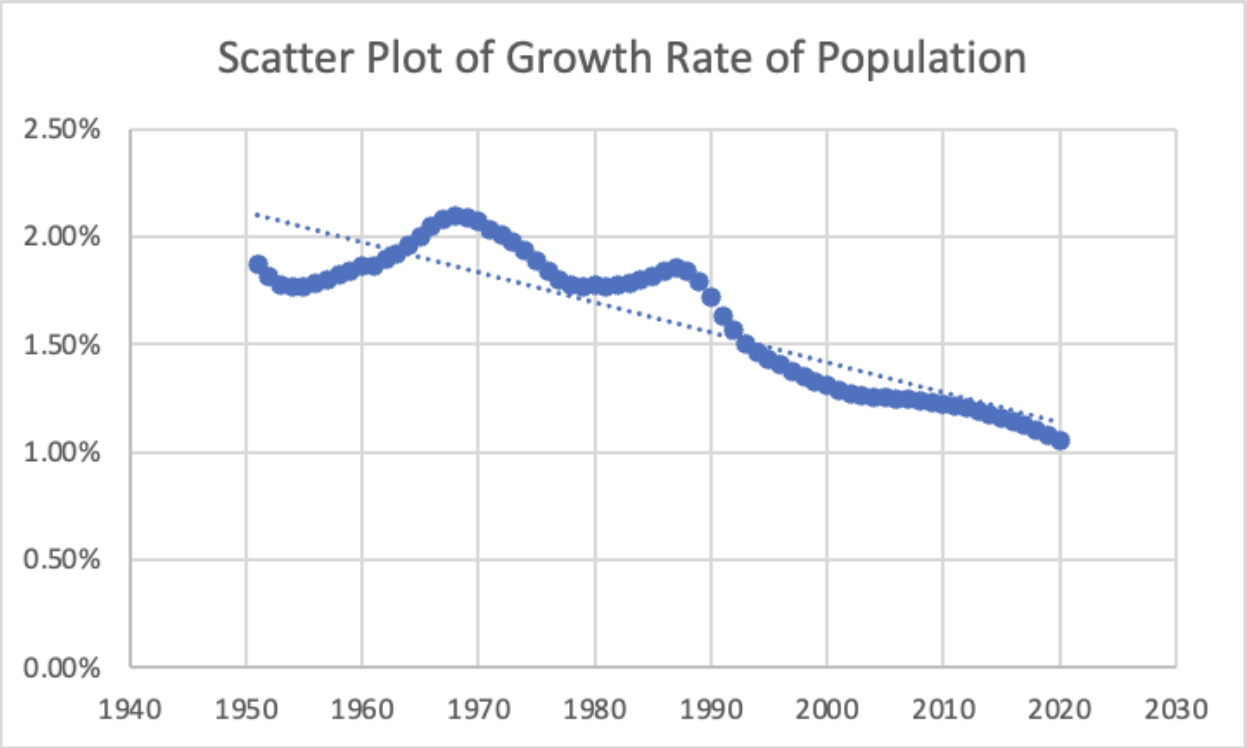
1955	4.901	2773019915	1.77%
1956	4.897	2822443253	1.78%
1957	4.902	2873306055	1.80%
1958	4.916	2925686678	1.82%
1959	4.936	2979576143	1.84%
1960	4.96	3035160180	1.87%
1961	4.985	3091843506	1.87%
1962	5.006	3150420759	1.89%
1963	5.021	3211000941	1.92%
1964	5.026	3273978271	1.96%
1965	5.016	3339583509	2.00%
1966	4.991	3407922630	2.05%
1967	4.95	3478770102	2.08%
1968	4.894	3551599432	2.09%
1969	4.824	3625680964	2.09%
1970	4.738	3700685676	2.07%
1971	4.638	3775760030	2.03%
1972	4.524	3851650585	2.01%
1973	4.403	3927780518	1.98%
1974	4.277	4003794178	1.94%
1975	4.153	4079480473	1.89%
1976	4.035	4154666824	1.84%
1977	3.928	4229505917	1.80%

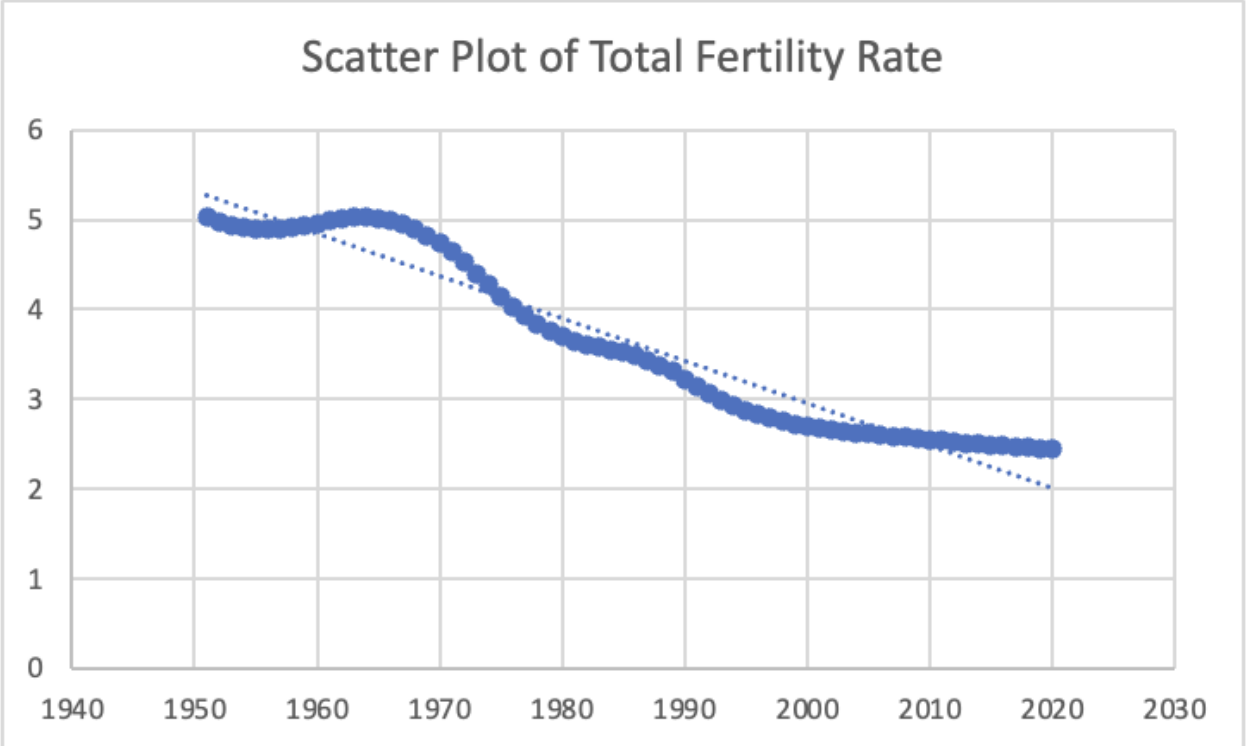
1978	3.834	4304533597	1.77%
1979	3.754	4380506180	1.76%
1980	3.691	4458274952	1.78%
1981	3.643	4536996616	1.77%
1982	3.607	4617386524	1.77%
1983	3.578	4699569184	1.78%
1984	3.553	4784011512	1.80%
1985	3.524	4870921665	1.82%
1986	3.487	4960567998	1.84%
1987	3.439	5052521994	1.85%
1988	3.379	5145425992	1.84%
1989	3.307	5237441433	1.79%
1990	3.227	5327529078	1.72%
1991	3.143	5414289382	1.63%
1992	3.061	5498919891	1.56%
1993	2.987	5581597596	1.50%
1994	2.922	5663150426	1.46%
1995	2.868	5744212929	1.43%
1996	2.824	5824891927	1.40%
1997	2.787	5905045647	1.38%
1998	2.755	5984794072	1.35%
1999	2.726	6064239030	1.33%
2000	2.701	6143776621	1.31%

2001	2.678	6222912459	1.29%
2002	2.659	6302062210	1.27%
2003	2.642	6381477292	1.26%
2004	2.627	6461454653	1.25%
2005	2.613	6542205330	1.25%
2006	2.6	6623819401	1.25%
2007	2.587	6706251239	1.24%
2008	2.575	6789396380	1.24%
2009	2.562	6873077808	1.23%
2010	2.549	6957137521	1.22%
2011	2.536	7041509491	1.21%
2012	2.524	7126144677	1.20%
2013	2.512	7210900157	1.19%
2014	2.501	7295610265	1.17%
2015	2.491	7380117870	1.16%
2016	2.481	7464344232	1.14%
2017	2.472	7548182589	1.12%
2018	2.462	7631091110	1.10%
2019	2.452	7713468203	1.08%
2020	2.442	7794798725	1.05%

Appendix C: Graphs and Charts




Scatter Plot of Growth Rate of Population
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030


Scatter Plot of Total Fertility Rate
6
5
4
3
2
1
0
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030