

Relationship between GDP, Life Expectancy and Growth Rate of G7 Countries

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Abstract: Increase in life expectancy is a key indicator to gauge the economic development of a country. Enormous studies have been done to test this hypothesis, and the conclusion is still un-decided. This study aims to explore the impact of life expectancy on economic growth in G7 countries via regression approach. Keeping in view the unique population structure of each of these G7 countries, the trend of life expectancy for each country is also observed. Findings of the study indicate that life expectancy in G7 countries increases with constant rate. The increase in life expectancy is accompanied with the increase in Gross Domestic Product (GDP) per capita income. We have also included the population growth rate as another important factor contributing towards GDP. It is worth mentioning here that increase in life expectancy directly affects per capita real income due to higher expenditure on health. Moreover, it is also found that increase in GDP lessens the population growth.

Keywords: G7 Countries, GDP

Introduction

In recent years, the increase in life expectancy has become a critical topic in population studies, as it is conditionally dependent on the economic growth and the expenditure on health improvement. According to World Bank report 1998, improvement in life expectancy is strongly linked with per capita income. It is expected that a prosperous country has a strong impact on the life expectancy of its inhabitants. An increase in GDP, normally decrease mortality rates, however, less developed countries experience mortality reduction in clusters of different age groups such as younger or working ages. Kelley and Schmidt (1995) explored that increase in population is neither all good nor all bad for economic growth, both elements coexist. Rodgers (1979) investigated that there exist a relationship between life expectancy, income and income distribution. On contrary, Becker, Philipson, and Soares (2003) suggested no such relationship.

On the other hand, economic growth is a key factor in raising standards of living worldwide and the role of population growth in the enhancement of living standards is a substantial part of it (see Heady & Hodge, 2009). There are abundant literature available which discusses the relationship between economic growth and population growth (Heady & Hodge, 2009). Past research shows that high income countries have relatively low population growth rate (Baker, DeLong, & Krugman, 2005). However, significant effects of population growth on economic disparity and on life expectancy are observed.

Various research analysts have investigated empirical evidence which showed that robust population

growth enhances economic growth. In contrast, few researchers found reverse evidence to this conclusion. Moreover, there are literatures which reveal that the effects vary with the level of a country's development, the source or nature of the population growth. The other factors that lead to non-uniform impacts on economic growth still need to be probed.

The main objectives of the study are many fold, (1) to observe the dependency of economic growth on population growth and life expectancy. (2) to explore the type of relationship between life expectancy, population growth and GDP in G7 countries which include US, UK, Canada, Italy, France, Germany and Japan.

Literature Review

E. Wesley F. Peterson (2017) studied the relationship between population growth and economic growth of high income and low income countries on globe and reviewed the related literature in this context. In their study they found that in low income group, the rapid increase in population will increase the demographic dividend in these countries as the young people become productive adults in future. On contrary, growth rate is low in high income group of countries. However, few countries show negative growth rate indicating that a high percentage of the population consists of elderly people. They investigated relationship between growth rate, growth in per capita output, and overall economic growth using past 200 years data. Their results reveal that low growth rate in high income countries and high growth rate in low income countries may create social and problems.



In the same year Linden, M., & Ray, D. (2017), analyzed health-income relationship spanning period from 1970 to 2010 of 148 countries. They used quantile regression method to find association between health and different income groups. They concluded that in low-income countries' income gradient is quite larger than that of rich countries. Income disparity is measured by Gini criterion which showed that the effect of inequality on health is still remarkable in the least income group of countries. On the other hand became insignificant among high-income group of countries after the year 2000.

Cervellati, & Sunde (2011) tested that the effect of life expectancy on income per capita growth is non-monotonic. In order to test the hypothesis they used 47 countries data taken from literatures (UN Demographic Yearbook, Maddison(2003)). Their result supports the previous findings on causal effect of life expectancy on income per capita growth. Furthermore, they concluded that improvement in life expectancy might affect the income growth indirectly as well as increases the probability of observing the demographic transition.

In 2002, Hasan explored long-run association between Growth rate and Per Capita Income of Bangladesh. His result exhibited that growth rate and GDP were cointegrated in long-run. Furthermore, a bidirectional relationship also exists between growth rate and GDP (Hasan, 2002). In another study (Hasan, 2010) examined the relationship between population and per capita income of China using Granger causality method. Empirical analysis, shows the existence of negative long-run causal relationship of per capita income with population growth and short-term association between growth and per capita income. In addition to this, he used neoclassical and endogenous growth models which indicated that per capita income growth tends to lower the population growth.

Schnabel & Eilers (2009) explored that the life expectancy has a nonlinear influence on wealth. They

followed research of Preston's study, in which life expectancy and GDP had a curvilinear relationship. They also used least asymmetrically weighted squares which led to combine *P*-spline curves. Different smoothers were applied on a large data set of different countries. Furthermore, their developed models were used to estimate changes in life expectancy of individual countries with the passage of time.

Model Selection and Data Analysis

The data of GDP (per capita income) and Life Expectancy of G7 countries are taken from World Bank web site www.worldbank.com. The data spans a period from 1960 to 2017. All countries GDP are taken into USD. All the GDP's are in billion (13 or more digits) so each country's GDP is divided by billion to ease the analysis procedure.

The model we have used for the analysis is a multiple linear regression model in two variables. The general form of the regression equation is described as;

$$GDP = C + b_1 \text{lifeexpectancy} + b_2 \text{growthrate} \dots\dots\dots(1)$$

$$\log(GDP) = C + b_1 \log(\text{lifeexpectancy}) + b_2 \log(\text{growthrate}) \dots\dots\dots(2)$$

Where C is a constant, 'b₁' is the coefficient measuring the effect of life expectancy on GDP and 'b₂' is the coefficient measuring the effect of population growth rate on GDP. The model (1) is further modified for the two group of G7 countries. One group, in which population growth is positive and another in which population growth is negative for some period of time. Log-Log Regression equation(2) is used for Canada, USA and Franc (having positive growth rate), whereas for the remaining countries standard regression equation(1) is considered.

The GDP, Life Expectancy and Population Growth rates are plotted separately for all G7 countries and are shown in Figure1 to figure 3.

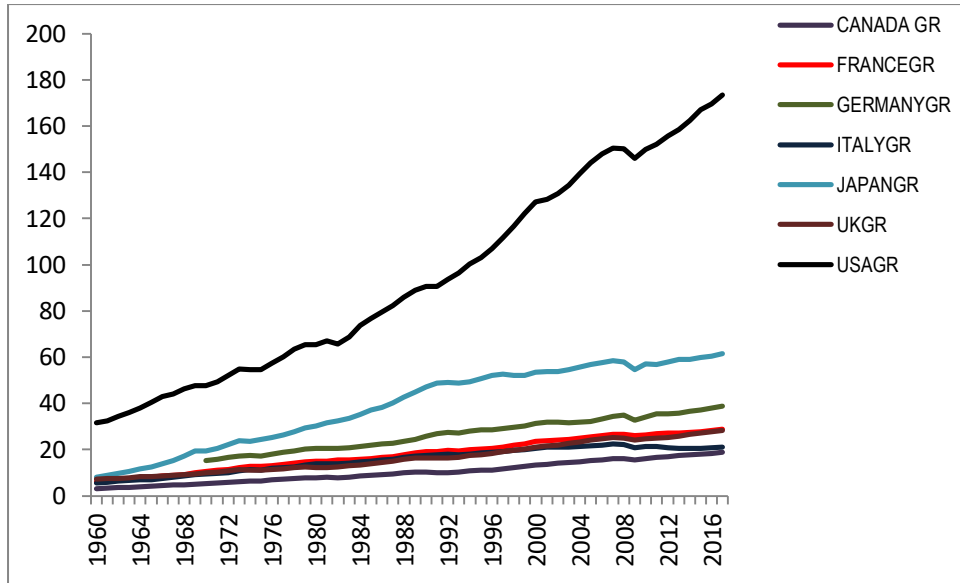


Figure 1: Annual GDP of G7 countries (in billions)

The Figure1 shows that the annual GDP of all G7 countries for the selected period has increasing trend except USA which has a non-linear trend. USA GDP stays on the uppermost part whereas France, Italy, UK, Germany and Japan are lying at the bottom. These countries have linear trend with low rate of increase.

Figure 2 shows that annual average Life expectancy of G7 countries linearly increases. Furthermore, at

the beginning of the selected period, i.e. Japan has lowest life expectancy among all G7 countries but it gradually increases and gains the highest position in the graph. Although, life expectancy of USA gradually increases from 1960 to 2017 but occupies the lowest position among all. Comparing Figure 1 and Figure 2 it is observed that GDP of USA increases exponentially from 1992 onward but the increase in Life expectancy does not follow this trend.

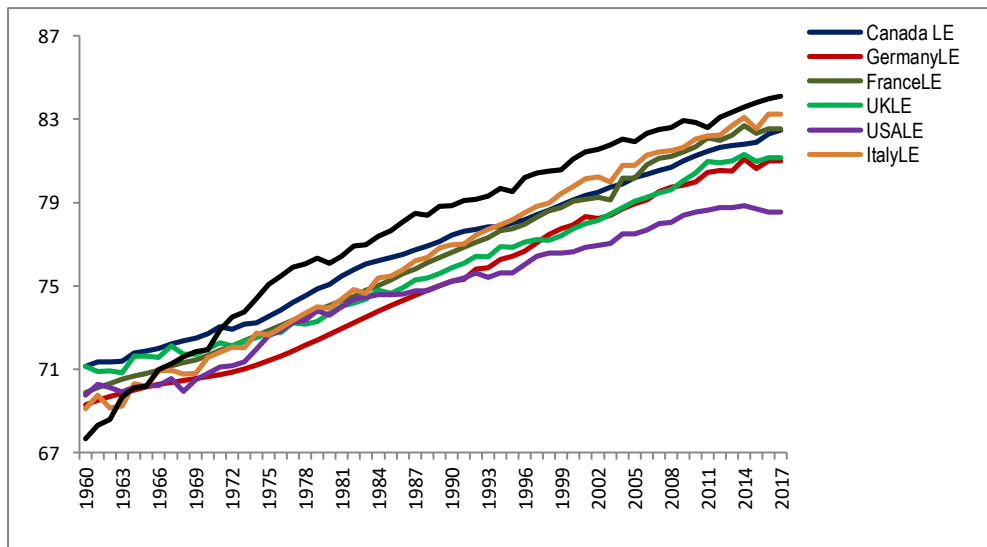


Figure 2: Graph of Life expectancy of G7 countries

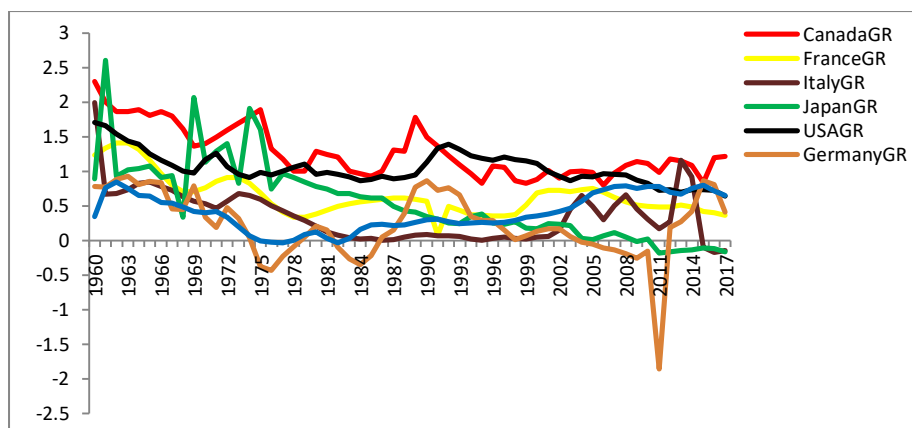


Figure 3: Graph of Annual Population Growth of G7 Countries

Figure 3, represents Annual Population Growth of G7 Countries. They do not come up with any clear trend, all are moving randomly, indicating an over-all decline in growth rate. Among all G7 countries, Germany has an unusual behaviour of positive and negative trend, specifically in the periods such as

1974 to 1986 and 2003 to 2012. Besides the Germany; Italy, Japan and UK has also negative growth rate for some specific period. When graphs of life expectancy and growth rate (Figure 2&3) are compared it is found that growth rate of Canada has prominent place although it has high and low peaks.

Table1:Displays the descriptive statistics

		Mean	Median	Maximum	Minimum	Std.Dev
UK	GDP	16.47	16.07	28.19	7.25	6.42
	Life expectancy	75.71	75.48	81.30	70.83	3.34
	Growth rate	0.40	0.35	0.85	-0.04	0.27
France	GDP	17.97	18.12	28.75	6.08	6.89
	Life expectancy	76.25	76.22	82.67	69.87	4.03
	Growth rate	0.64	0.57	1.41	0.08	0.29
Italy	GDP	15.52	16.87	22.34	5.46	5.31
	Life expectancy	76.41	76.60	83.24	69.12	4.40
	Growth rate	0.36	0.29	1.99	-0.17	0.38
Canada	GDP	10.20	9.91	18.84	3.16	4.64
	Life expectancy	76.75	77.02	82.47	71.13	3.49
	Growth rate	1.28	1.18	2.30	0.80	0.37
US	GDP	93.58	87.36	173.49	31.71	43.78
	Life expectancy	74.67	74.89	78.84	69.77	2.96
	Growth rate	1.04	0.98	1.70	0.64	0.23
Germany	GDP	22.30	23.95	38.84	0.00	12.05
	Life expectancy	75.01	74.90	81.09	69.31	3.83
	Growth rate	0.23	0.19	0.93	-1.85	0.48
Japan	GDP	39.09	43.80	61.58	7.96	17.21
	Life expectancy	77.68	78.65	84.10	67.67	4.65
	Growth rate	0.56	0.40	2.61	-0.19	0.58

Table1 displays the descriptive statistics of the GDP, growth rate and life expectancy of G7 countries in the selected period. The average GDP of USA is high i.e. 93.58 while Canada has the lowest GDP of all i.e. 10.2 billion. Whereas, average Life Expectancy (77.45) of Japan is high, on contrary USA has minimum average value (74.534). Moreover, Canada has high average growth rate while Germany has lowest value of average growth rate among G7 countries. The high growth rate of Canada may be due to the fast and simple immigration policy as

compared to other G7 countries. Additionally, the standard deviation of life expectancy is highest in Japan which shows high variability. In contrast, US has less variability in the life expectancy as the standard deviation is minimum among all. This fact can be observed from Figure 2. Population growth rate is highest in Canada(1.28) followed by US(1.04), the minimum value of population growth rate is observed for Germany(0.23).

Table2:Regression output of G7 countries

Country	b ₁	b ₂	R-sq
Canada	10.25 (0.32)* (0)**	-0.169 (0.053)* (.002)**	0.98
France	7.53 (0.275)* (0)**	-0.130 (.0310)* (.0001)**	0.954
Germany	2.78 (0.155)* (0.0068)**	-3.53 (1.25)* (0.000)**	0.87
Italy	1.11 (0.03)* (0.0002)**	-1.63 (0.402)* (0.000)**	0.96
Japan	3.4 (0.143)* (0)**	-2.37 (1.14)* (.04)**	0.97
UK	1.87 (0.037)* (0)**	0.823 (0.467)* (0.08)**	0.98
USA	12.19 (0.368)* (0)**	-0.094 (0.0688)* (0.1778)**	0.97

Note: Authors calculations, *represents Standard error and ** indicates P-value

Table 2 reports the regression coefficients when GDP is regressed on life expectancy and population growth rate. The coefficients of life expectancy are highly significant in each of seven countries with positive coefficients. The coefficients of population growth rate are significant in Canada, France, Germany, Italy and Japan and are insignificant for UK and USA. It is also found that all countries except UK have negative coefficients (in significant). The high values of coefficient of determination R² indicate fairly good fit to each of G7 countries. The findings in Table 2 are further confirmed by computing the correlations between the three variables of interest.

Table 3:Correlation Coefficient between GDP, population growth and growth rate of G7 countries

Country	Corr. Coefficient. b/w GDP&Growth rate	Corr. Coefficient b/w GDP& life expectancy	Corr. Coefficient b/w Growth rate & life expectancy
Canada	-0.5734	0.9225	-0.7743
France	-0.4753	0.97086	-0.5714
Germany	-0.07322	0.96771	-0.07594
Italy	-0.2223	0.95901	-0.3902
Japan	-0.8219	0.91784	-0.8145
UK	0.52954	0.96935	0.38509
USA	-0.54095	0.93985	-0.58296

Table 3 represents the correlation coefficients between GDP and Population Growth Rate, between GDP and Life Expectancy, and between Population Growth Rate and Life Expectancy. Correlation coefficients between GDP and Population Growth Rate are all negative except for UK, where it is positive, and the coefficient for Germany reports very weak negative correlation. The correlation coefficients between GDP and Life Expectancy are highly positive for all seven countries, showing a strong bonding between the two variables. Further the correlation coefficients between Population Growth Rate and Life Expectancy are negative for all countries excluding UK once again.

Conclusion:

This study aims to study the GDP (per capita income), population growth rate and life expectancy of G7 countries. Studies showed that high income group countries lead to increase in the life

expectancy. Increase in life expectancy means a large number of elderly people which may cause overburden on economy of the country. Empirical analysis shows that Japan has highest average GDP and life expectancy. But the growth rate of Canada is high among all G7 countries, this may be due to a large proportion of immigrants. The findings of the study agree with the existing empirical studies, which say that countries in the higher income group have low population growth accompanied by higher life expectancy (see Table1). This phenomenon is a special feature of G7 countries which is quite unnatural as the population structure in each of these seven countries is away from what is called the healthy structure of population.

Future Studies:

The current study is carried out only for G7 countries having common trends regarding GDP and life expectancy. However the same study may yield

different results if done for developing and under developing countries.

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