



Healthy Gross Domestic Product (HGDP) Regressed from Life Expectancy: Novel Economic Criterion of Social Development

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Abstract

Life expectancy (LE) is pertinent to the core interests of humans because health and life are the most precious wealth of humans. LE is determined by multiple social aspects including economy, safety, health, environment, education, innovation, human behaviors, and propaganda. Therefore, taking LE as a social development criterion is in line with the core interests of humans and facilitates harmonious development of multiple social aspects. In this sense, LE is superior to gross domestic product (GDP) to be taken as a social development criterion, as the GDP-based criterion may ignore safety, health, environmental protection, social equality and justice. However, because LE is not an economic indicator and is not directly corresponding to GDP, LE is unsuitable to replace GDP in the economic field as a social development criterion. In this report, healthy GDP (HGDP) per capita is defined as the GDP per capita regressed according to the exponential relationship between LE and GDP per capita using the independent variable of LE, and HGDP is defined as the product of population and HGP per capita, and relative economic efficiency (REE) is defined as the ratio of HGDP versus GDP. Taking HGDP or HGDP per capita as a social development criterion is in line with the core interests of humans, and facilitates harmonious development of multiple social aspects. Therefore, HGDP is suitable to replace GDP in the economic field as a social development criterion. HGDP and REE are easy to be estimated, and can influence macroeconomic and microeconomic decisions. We also discuss the relationship between HGDP and gross national income, human development index, and green GDP, and elucidate that, when we take HGDP as a criterion of social development of a region, we should not only analyze whether its HGDP has increased, but also analyze the major issues that humans in that region have been affected by the past and have done for the future.

Keywords

gross domestic product; harmonious development; life expectancy; economic efficiency; macroeconomics; microeconomics

Abbreviations

GDP, gross domestic product; GGDP, green gross domestic product; GNI, gross national income; HDI, human development index; HGDP, healthy gross domestic product; LE, Life expectancy; REE, relative economic efficiency

Introduction

GDP growth has been taken as the pivotal criterion of social development for a long time. Some people even think that GDP growth represents social progress, and decline of GDP growth rate represents decline of social progress rate, and decline of GDP represents social retrogression. This GDP-based criterion of social development highlights the importance of economic development, and may ignore environmental protection, health, safety, and social equality. In reality, this view may guide the government to make unscientific decisions. For example, in order to achieve the goal of GDP growth, some local governments may ignore its people's health and environment protection to develop some industries with high pollution [1, 2]. Therefore, the GDP-based criterion of social development is of drawbacks and has been widely criticized.

Although GDP is of problems to be taken as the criterion of social development, a superior economic indicator has not been proposed to replace GDP. To solve this problem, this paper introduces the novel concepts of healthy gross domestic product (HGDP) and relative economic efficiency (REE) through exponential regression using life

expectancy (LE). This paper also elaborates whether HGDP is superior to GDP to be taken as the criterion of social development in the economic respect.

LE

If the death rate of people of all ages in a region during a year will remain unchanged in the next few decades, the number of years for humans who were born that year to keep alive can be calculated, and the number is the LE value of the region that year.

As health and life is the most precious wealth of almost every one, LE is an important index of well-being of humans, and pertinent to the core interests of humans. The LE value of a region is determined by multiple parameters [3-16]. Bloody wars in many countries in the history [3], rampant violence in Mexico and Honduras [7], natural disasters like earthquakes, tsunamis or droughts in various countries [3], poverty in many African countries [8], low-quality medical services in many rural regions [9], environment pollution in some regions of China [10], frequent traffic and unexpected accidents in China [3], infectious diseases like AIDs in Africa [11], abuse of narcotics in United States and Philippines [12], alcoholism in Russia [13], smoking in some developed regions [14], and obesity in United States [3], and wealth inequality in Swaziland and United States [15], all have inhibited or is inhibiting the increase of the LE values of the relevant regions. These facts suggest that LE increase requires harmonious development of various social aspects including national defense, public security, economy, education [16], equality, reforming, research, and propaganda, to maintain a peaceful and safe society, prevent and control disasters, dismiss poverty, upgrade medical services, minimize traffic and unexpected accidents, eliminate infectious diseases, and control narcotics, alcoholism, smoking and obesity.

Because LE is an important index of well-being of humans, and LE increase requires harmonious development of various social aspects, LE can be and has been taken as a criterion of social development. Consistent with this view, the LE values of many countries or regions have increased significantly as compared with decades ago or hundreds of years ago, and the LE values of developed countries are usually higher than developing countries, although a richer country is not always of a higher LE value due to that LE is not determined only by economy. Additionally, we shall also discuss how we should correctly the LE-based criterion of social development below.

Although LE is superior to GDP to be taken as a social development criterion, LE is unsuitable to replace GDP in the economic field as a social development criterion, because LE is not an economic indicator and is not directly corresponding to GDP. To solve this problem, the concept of HGDP is introduced in this article.

HGDP

Figure 1 contains two coordinates. Their abscissas are the LE values of 147 countries or regions with populations more than one million in the years 2000 and 2010, and their ordinates are the GDP per capita values of these countries or regions in the two years (data from the World Bank Database). These two coordinates show that the LE values and the GDP per capita values are likely in exponential correlation, as the LE values increase at a decreasing rate with respect to the GDP per capita values, which is consistent with the relevant reports [3-5]. Their correlation coefficients are 0.7937 and 0.8034 as calculated by Microsoft Excel software, suggesting that the LE values are significantly correlated with the GDP per capita values ($P < 0.01$).

In this article, healthy gross domestic product (HGDP) is defined as the product of population and HGDP per capita, and HGDP per capita is the GDP per capita exponentially regressed according to the exponential relationship between LE and GDP per capita using the independent variable of LE. The ratio of HGDP versus GDP, or the ratio of HGDP per capita versus GDP per capita, is defined as REE.

As shown in Figure 1, the exponential correlation curves are different for different years. This can cause difficulty in comparing HGDP data of different years. To solve this problem, the exponential correlation curves of the

years 1990, 2000, 2010, 2020 are designated as the standard curves for calculation of HGDP values of the pertinent decades.

To minimize errors, the data used for the exponential regression are only from the countries or regions with populations more than one million and statistic data of population, LE, GDP per capita having been available for at least five years in the database of World Bank.

Table 1 and Table 2 are the HGDP and REE values of some countries in 2010 and 2014 regressed from the standard exponential curve of the year 2010 ($y = 0.4461e^{0.1322x}$). To be correct, the HGDP values are expressed as those regressed per the year 2010.

Because LE can be and has been taken as a criterion of social development, HGDP per capita which is regressed from LE can also be taken as a criterion of social development. Similarly, because LE is an important index of well-being of humans, and LE increase requires harmonious development of various social aspects, HGDP per capita is also an important index of well-being of humans, and HGDP per capita increase requires harmonious development of various social aspects. Additionally, we shall also discuss how we should correctly the HGDP-based criterion of social development below.

In nature, HGDP per capita represents the expected GDP per capita required to support a certain value of LE in term of the world average.

Like LE, HGDP per capita cannot reflect the total volume of a country or region. Therefore, HGDP is introduced and defined as the product of population and HGDP per capita.

According to the above inferences, HGDP increase requires harmonious development of various social aspects including population. The interaction between population and other social aspects are complicated [17]. First, when the natural or social environment is more affluent or amiable, population likely grows; when the natural or social environment is not affluent or amiable, population growth is likely inhibited. Second, populations of some rich countries or regions decline due to various reasons including late marriage and high cost for maintaining high-level of living quality. Third, when population increases at a proper rate in an affluent or amiable environment, population increase can be helpful for harmonious development of various social aspects, but if population increases at a too high rate, population increase can be harmful for harmonious development of various social aspects.

When we analyze the social development of the same country or region in different periods, HGDP and HGDP per capita can both be taken as criteria of social development. When we compare two countries of distinct populations, HGDP per capita is superior to HGDP to taken as the criterion of social development. Taking HGDP as the criterion of social development in this article is equal to taking HGDP or HGDP per capita the criterion of social development.

Some people may ask why we should introduce the concepts of HGDP and HGDP per capita, rather than directly use LE as the criterion of social development? First, HGDP is introduced not for replacing LE, and LE remains to be a social criterion of social development. Second, because HGDP is an economic indicator that is closely related with GDP, HGDP is superior to LE which is a social and health indicator, to replace GDP as the economic indicator of social development. Third, it is easier for people to understand the economic value of LE increase through HGDP. For example, compared to the year 2010, China's LE grew by 0.775 years in 2014, corresponding to an increase of HGDP by 1.6 trillion USD. If there were no HGDP, it should be difficult for people to understand the economic value of China's LE increase by 0.775. Additionally, the concepts of HGDP and HGDP per capita can be used for calculating social economic efficiency as explained below.

REE

As we know, some kinds of production are useful (e.g. production of a proper number of washing machines),

and some other kinds of production are useless (e.g. overproduction of low-quality steel at great cost of environment pollution). Moreover, some kinds of production can be useful in one sense and useless in another sense. For example, the vaccine production and vaccination against rabies in a country with prevalent rabies cases are useful as compared with those countries which are also with prevalent rabies cases, but useless as compared with those countries without rabies cases for years.

As we also know, the living costs in different regions are different for the same living quality. For example, people living in a region with rampant crimes have to pay much for safety protection, and people living in a region with prevalent HIV infections have to pay much for prevention and control of the disease.

If the useful proportion of GDP is high, and the living cost for the same living quality is low, the ratio of HGDP versus GDP is high. If the useful proportion of GDP is low, and the living cost for the same living quality is high, the ratio of HGDP versus GDP is low. Therefore, REE (the ratio of HGDP versus GDP) reflects a kind of economic efficiency. It is “relative” because of the following reasons.

First, when REE is equal to 100%, this does not mean that the REE value reaches the highest level, but means that the value reaches the world average level. The REE values of China in 2010 and 2014 are 198.36% and 130.48% (Table 1 and Table 2), suggesting that, in terms of the world average, various social aspects in China were in harmonious development in those two years (Although the environment pollution was serious in some regions in China, the society was peaceful and stable with good control of crimes, infectious diseases, drug abuse, and most Chinese people were happy with their jobs and families).

Second, as the HGDP values are calculated according to the exponential regression curves of certain years (e.g., the HGDP values of 2016 should be calculated according to the exponential regression curve of the year 2010), the REE values are usually in terms of certain years. For example, if the REE value of a region in 2016 is 100%, it means that the REE value reaches the world average of the year 2010 rather than 2016.

Third, the REE values are closely related to living costs. For example, country A and country B share the same GDP per capita and the same proportion of useful GDP per capita, but country A is heavily affected by the infectious disease of AIDs, while country B is of no burden of the disease. This can lead to that the living cost in country A is higher than the living cost in country B for the same living quality. Consequently, the REE of country A is likely lower than that of country B.

In nature, REE is a ratio. A rich country and a poor country may be quite different in the values of LE, GDP per capita, and HGDP per capita, but they may share the same REE. Therefore, sometimes it is of no much sense to compare the REE values without consideration of the relevant GDP per capita or HGDP per capita.

Applications

It is needed to discuss how we should correctly take LE or HGDP as the criteria of social development before we explain their applications.

First, when we take LE or HGDP as a criterion of social development, we should know that the criterion cover little about the aspect of liberty, democracy, science and arts, although the criterion covers various other social aspects including security, health, economy, environment protection, equality, etc. Nevertheless, we should recognize the facts that health and life is the most precious wealth of almost every one, and is the pivotal basis for a man to engage in all issues including liberty, democracy, science and arts.

Second, as a criterion of social development, LE or HGDP is somehow lagging or of hysteresis. For example, if humans of a region work hard (e.g. fight against foreign aggression, repay a big amount of debt, or build massive high-quality infrastructure) in a year mainly for the future rather than only for that year, the LE or HGDP value of that year may be underestimated as compared with humans’s contribution of that year. For another example, if humans of a region infringe greatly the interest of the future (e.g. borrow much money for living) in a year, the LE or

HGDP value of that year may be overestimated as compared with humans's contribution of that year. Therefore, when we take LE or HGDP as a criterion of social development of a region, we should not only analyze whether its LE or HGDP has increased, but also analyze the major issues that humans in that region have been affected by the past and have done for the future. In another word, when we take LE or HGDP as a criterion of social development of a region, we should observe not only whether its LE or HGDP has increased, but also what humans of that region have done for sustainable growth of its LE or HGDP values.

As a criterion of social development, LE or HGDP may be also lagging for environment protection. This is due to the fact that some health problem caused by environment pollution is chronic. Nevertheless, as a criterion of social development, LE or HGDP is beneficial to environment protection through the following two ways. First, according to the criterion, the existing environment problems which are inhibiting LE or HGDP growth shall be solved as soon as possible to enhance the current LE value. Second, as mentioned above, when we take LE or HGDP as a criterion of social development of a region, we should not only analyze whether its LE or HGDP has increased, but also analyze the major issues that humans in that region have been affected by the past and have done for the future, and these analyses should make decision-makers more active in the prevention of new environment problems no matter whether they affect the current or future LE value.

We think that taking HGDP as the criterion of social development is superior to taking GDP as the criterion, because the former leads to harmonious development of various social aspects, and the later may ignore the significance of environmental protection, health, safety, harmony between man and nature, social equality and justice, leading to disharmonious development of various social aspects which is opposite to the willing and core interest of humans.

The HGDP-based criterion and the GDP-based criterion may offer contrary judgments on the following two scenarios ([Table 3](#)). The first scenario is that the GDP of a region increased but its HGDP declined. This scenario is of social progress per the GDP-based criterion because its economy increased, and possibly of social retrogression per the HGDP-based criterion because its people health possibly declined which further suggests possible disharmonious development of various social aspects. We use the words "possible" and "possibly" in the last sentence, because we have not analyzed what humans in that region were affected by the past and did for the future. The second scenario is that the GDP of a region declined but its HGDP increased. This scenario is of social retrogression per the GDP-based criterion because its economy declined, and possibly of social progress per the HGDP-based criterion because its people health possibly increased which further suggests possible harmonious development of various social aspects.

The scenario that the HGDP of a region increased by 3% in a year and its GDP declined by 1%, may be superior to the scenario that the HGDP of that region increased by 3% that year and its GDP increased by 1%. This is because the former scenario is of a higher REE that year, indicating that possibly various aspects of the region was more harmonious that year, and/or the living cost of the region declined that year. Therefore, sometimes decline of GDP could be a beneficial signal.

Changes of the HGDP and REE of a country or region can reflect its governance performance in the relevant period. [Table 4](#) and [Table 5](#) show the HGDP values of the top 20 countries all increased during the period 2010–2014. It should be mentioned that the GDP values of Japan, Spain and Iran fell in 2014 as compared to the year of 2010, but their HGDP increased. This suggests that possibly the three countries had made some social progress although their GDP declined.

The value of HGDP and HGDP per capita of different countries or regions of the world in the same year can reflect the total and per capita volume of human well-being in a country or region. [Table 4](#) and [Table 5](#) show the world's top 20 countries in 2010 and 2014 regarding their HGDP values. The top 4 were China, United States, India, and Japan. In these two years, China's HGDP (12.1–13.7 trillion USDs) were 2.7–2.8 times of those of United States,

but the HGDP per capita values of United States were 1.5–1.6 times of those of China.

If the GDP value of a region is greatly higher than its HGDP, or if the REE value is too low, this suggests that one or more aspects of the region is under great disharmony with others. The REE values of Swaziland, South Africa, and Angola in 2010 were less than 10%, indicating that the development of these three countries were of a serious imbalance that year in terms of their economic levels and the world average. In effect, in 2010, these three countries were of the heavy burdens of AIDS and wealth disparity.

If the HGDP value of a region is greatly higher than its GDP, or if the REE value is very high, this suggests that various aspects of the region are under quite harmony with each other in terms of the world average for regions of similar economic levels. The REE values of Vietnam, Bangladesh, Madagascar, Tajikistan, and Kyrgyzstan in 2010 were all greater than 400%, indicating that the development of these five countries in various aspects were relatively harmonious that year in terms of their economic levels and the world average. In effect, the five countries were of no serious problems relating to natural disasters, infectious diseases, social security, and environment pollution.

The key issues inhibiting HGDP growth should be the key development targets of a country or region provided the country or region holds the HGDP-based criterion of social development. It requires to end a war in Syria [3], promote economy in Venezuela [3-5], improve social security in Mexico and Honduras [7], protect environment in some areas in China [10], prevent from traffic and unexpected accidents in China [3-5], control AIDS in South Africa and Namibia [11], curb wealth inequality in Swaziland and United States [3, 15], minimize narcotics abuse in United States [12], alcoholism in Russia [13], control smoking and obesity in some rich regions [3, 14], to properly enhance the HGDP values of the relevant countries or regions.

We assume that it is relatively ideal if the LE value of a region reaches 75 years. As shown in Figure 1, it does not require very high GDP per capita to support the LE value of 75. This demonstrates the rationality of a proper volume of production and consumption which are of great significance for the current world. Nowadays, with rapid development of technologies, human productivity increases rapidly, and consequently, overproduction is more and more serious. If we further emphasize the growth of GDP, we have to encourage overconsumption to digest the products not necessary for living. This cycle of overproduction and overconsumption is contrary to traditional virtue of thrift, and not good for environment protection and sustainable development. According to the HGDP-based criterion of social development, the cycle of overproduction and overconsumption can be avoided, because overproduction and overconsumption are of little positive influence on HGDP growth, and reduce the value of REE.

The above applications of HGDP and REE suggest that these two novel concepts can be influential for macroeconomic and microeconomic policies in the future. For example, HGDP and REE may be selected as the development indexes of some countries, and more resources shall be given to environment pollution, social security, traffic safety, smoking control, economic equality, etc.

Discussion

Similar concepts (e.g. health gross national income) and views can be derived if we replace the concept of GDP in this article with gross national income (GNI). Because GDP is more influential than GNI, we select GDP rather than GNI in this article.

The LE values are also related to genders, and usually the LE values of females are higher than those of males [3-5]. Because usually no countries take any measures to improve the proportion of females except for those with serious scarce of females, genders have not been considered in this article.

The LE values are also related to races [3-5]. No matter whether this relationship is caused by genetics, increase of the HGDP value of a race also requires harmonious development of various social aspects including economy, population, safety, health, environment, education, innovation, human behaviors, and propaganda of the

race.

Taking HGDP increase as the criterion of social development is consistent with the biggest hopes of many families which hope that all their family members are healthy. The criterion is also consistent with the history which showed that many wars led to slump of population and the LE values, representing a miserable and retrogressive scenario. After the wars, both population and the LE values usually increased rapidly, representing a progressive and reviving scenario.

There are two approaches to increase the HGDP values of a region: increasing its population which leads to linear increase of its HGDP, and increasing its HGDP per capita which leads to exponential increase of its HGDP. As explained above, these two approaches require harmonious development of various aspects including population. China has implemented the family planning policy for decades, and in recent years many families in China no longer expect to have multiple children, but they continue to list health of their family members and longevity as their most important wish. All these facts are consistent with the HGDP-based criterion. In addition, the populations of Japan, Spain, and Puerto Rico declined in recent years, but their HGDP increased due to increase of their LE values.

Another concept, green GDP (GGDP), has been proposed to minimize the negative influence of GDP [18]. GGDP focus on three parameters, GDP, resource consumption and environmental pollution cost. Obviously, GGDP covers less social aspects than HGDP. Moreover, calculation of GGDP is quite complicated, while calculation of HGDP is quite straightforward.

Beside the LE indicator, human development index (HDI) has been used to as an indicator of human well-beings. HDI is an index covering three parameters, the LE value, education and economy. HDI is also largely in an exponential relationship with GDP. However, calculation of HDI is of inherent theoretical contradictions and statistical difficulties [19]. Calculation of HDI is of inherent theoretical contradictions because the calculation assumes that LE, education and economy are independent factors. Actually, the parameters of LE, education and economy are not independent factors, but dependent on each other, because good education and strong economic support are usually essential to maintain a high LE value, and strong economic support is usually essential to provide good education for humans, and good health of humans indicated by a high LE value is usually essential for strong economic and educational development. Moreover, it is difficult to quantify the educational level of a country or region which should consider its educational basis, educational contents, learning years, educational efficiency, basic education, high education, educational equality, etc. In addition, it is difficult to quantify the economic strength of a country or region which should consider wealth inequality, economic basis, economic volume, living costs, economic structure, etc. With these considerations, it is assumed that HDI is not superior to LE as an indicator of human well-beings.

As explained above, when we take HGDP as a criterion of social development, various social aspects including economy, safety, health, environment, education, innovation, human behaviors, and propaganda are smartly covered and integrated into the parameter of HGDP. However, we should know that this HGDP-based criterion does not cover the significance of liberty, democracy, science and arts, and these aspects should be analyzed separately through other approaches.

In summary, HGDP is superior to GDP to be taken as an economic criterion of social development, because the HGDP-based criterion is useful for making scientific policies and decisions, and it shall facilitate harmonious development of various aspects. On the other side, when we take HGDP as a criterion of social development of a region, we should observe not only whether its HGDP has increased, but also the major issues that humans in that region have been affected by the past and have done for the future.

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Figure(s)

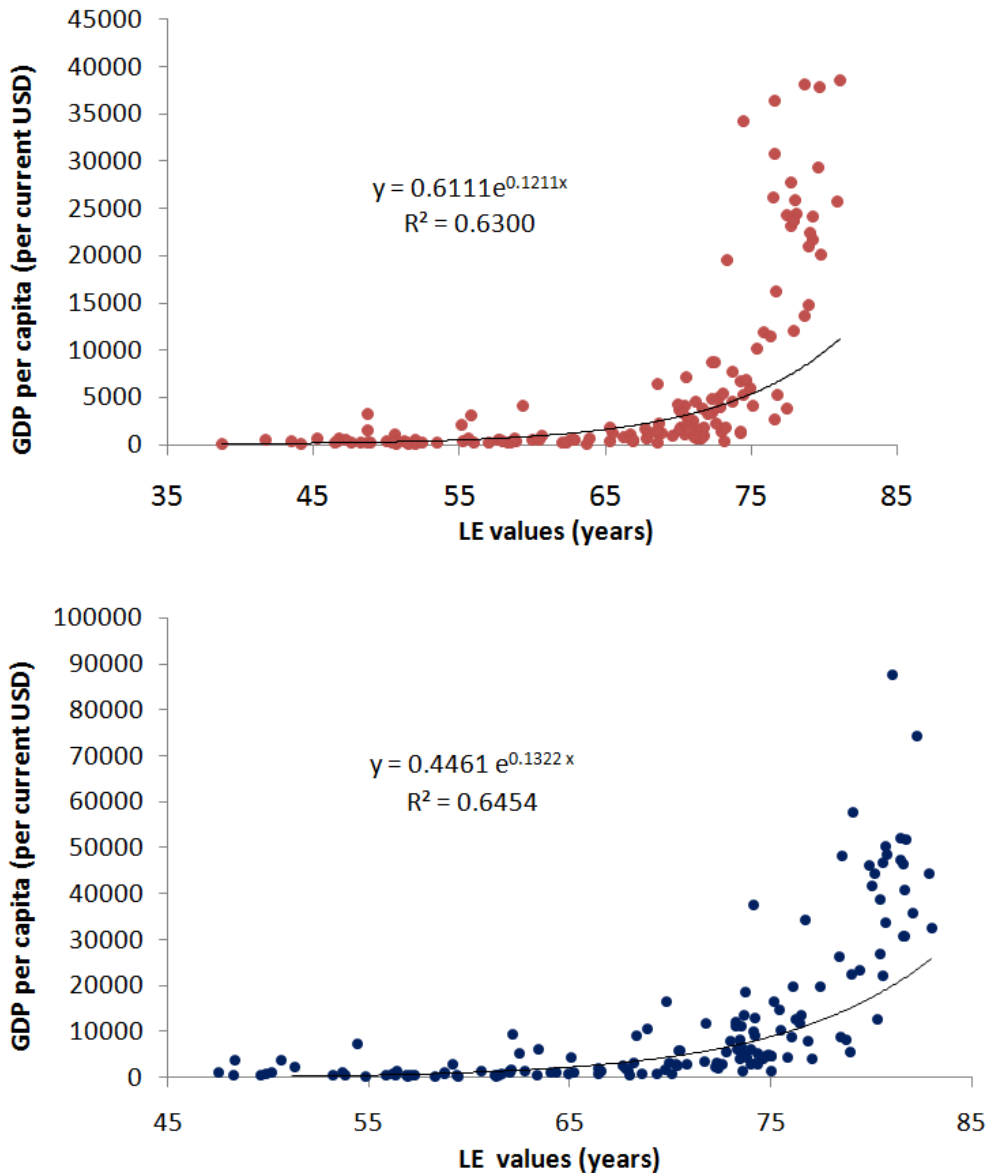


Figure 1. The exponential relationship between LE and GDP per capita of 147 countries or regions in 2000 (the upper) and 2010 (the below).

Table(s)

Table 1. HGDP and REE of some countries or regions in 2010 (regressed per the year 2010, and GDP or HGDP are in current USD)

Country / Region	Population	LE	GDP per capita	GDP	HGDP per capita	HGDP	REE
Argentina	41222875	75.485	10332.03	4.26E+11	9622.907	3.97E+11	93.14%
Australia	22031750	81.695	51845.63	1.14E+12	21870.260	4.82E+11	42.18%
Brazil	198614208	73.264	11121.41	2.21E+12	7174.641	1.42E+12	64.51%
Canada	34005274	81.413	47445.88	1.61E+12	21069.395	7.16E+11	44.41%
Chile	17015048	80.276	12785.04	2.18E+11	18128.658	3.08E+11	141.80%
China	1337705000	75.007	4560.51	6.10E+12	9034.159	1.21E+13	198.10%
Egypt	82040994	70.340	2668.03	2.19E+11	4874.508	4.00E+11	182.70%
France	65027512	81.663	40705.69	2.65E+12	21778.778	1.42E+12	53.50%
Germany	81776930	79.988	41788.07	3.42E+12	17451.409	1.43E+12	41.76%
Greece	11121341	80.388	26919.33	2.99E+11	18399.075	2.05E+11	68.35%
India	1230984504	66.506	1345.72	1.66E+12	2936.285	3.61E+12	218.19%
Indonesia	241613126	68.147	3125.22	7.55E+11	3647.682	8.81E+11	116.72%
Iran	74253373	73.983	6299.92	4.68E+11	7890.092	5.86E+11	125.24%
Israel	7623600	81.602	30662.02	2.34E+11	21603.925	1.65E+11	70.46%
Italy	59277417	82.037	35851.43	2.13E+12	22880.137	1.36E+12	63.82%
Jamaica	2690824	74.847	4902.67	1.32E+10	8845.160	2.38E+10	180.42%
Japan	128070000	82.843	44507.69	5.70E+12	25453.042	3.26E+12	57.19%
Kenya	40328313	58.719	991.85	4.00E+10	1048.785	4.23E+10	105.74%
South Korea	49410366	80.551	22151.22	1.09E+12	18800.882	9.29E+11	84.88%
Laos	6260544	64.334	1138.53	7.13E+09	2203.262	1.38E+10	193.52%
Madagascar	21079532	63.362	414.14	8.73E+09	1937.607	4.08E+10	467.86%
Mexico	118617542	76.027	8861.51	1.05E+12	10337.447	1.23E+12	116.66%
Morocco	32107739	72.577	2903.25	9.32E+10	6551.554	2.10E+11	225.66%
Myanmar	51733013	64.917	957.62	4.95E+10	2380.057	1.23E+11	248.54%
Norway	4889252	80.998	87646.33	4.29E+11	19943.637	9.75E+10	22.75%
Peru	29373644	73.640	5021.24	1.47E+11	7539.944	2.21E+11	150.16%
Philippines	93038902	67.783	2145.24	2.00E+11	3476.365	3.23E+11	162.05%
Russia	142849449	68.856	10675.01	1.52E+12	4006.062	5.72E+11	37.53%
Saudi Arabia	28090647	73.702	18753.96	5.27E+11	7601.803	2.14E+11	40.53%
Singapore	5076732	81.541	46569.72	2.36E+11	21430.477	1.09E+11	46.02%
South Africa	50771826	54.391	7392.86	3.75E+11	591.846	3.00E+10	8.01%
Spain	46576897	81.627	30737.77	1.43E+12	21673.697	1.01E+12	70.51%
United Kingdom	62766365	80.402	38708.63	2.43E+12	18434.705	1.16E+12	47.62%
United States	309346863	78.541	48374.18	1.50E+13	14414.203	4.46E+12	29.80%
Vietnam	86932500	74.990	1333.59	1.16E+11	9013.820	7.84E+11	675.91%

Table 2. HGDP and REE of some countries or regions in 2014 (regressed per the year 2010, and GDP or HGDP are in current USD)

Country / Region	Population	LE	GDP per capita	GDP	HGDP per capita	HGDP	REE
Argentina	42980026	76.159	12324.93	5.30E+11	10519.19	4.52E+11	85.35%
Australia	23464086	82.251	61996.02	1.45E+12	23538.65	5.52E+11	37.97%
Brazil	206077898	74.402	11728.82	2.42E+12	8339.15	1.72E+12	71.10%
Canada	35543658	81.957	50185.61	1.78E+12	22639.51	8.05E+11	45.11%
Chile	17762647	81.496	14566.13	2.59E+11	21302.61	3.78E+11	146.25%
China	1364270000	75.782	7683.52	1.05E+13	10008.64	1.37E+13	130.26%
Egypt	89579670	71.122	3365.71	3.46E+11	5404.99	4.84E+11	160.59%
France	66495940	82.373	42696.74	3.01E+11	23921.22	1.59E+12	56.03%
Germany	80982500	80.844	47902.70	2.84E+12	19542.60	1.58E+12	40.80%
Greece	10892413	81.285	21673.80	3.88E+12	20717.07	2.26E+11	95.59%
India	1295291543	68.014	1576.82	2.36E+11	3583.92	4.64E+12	227.29%
Indonesia	254454778	68.888	3499.59	2.04E+12	4023.25	1.02E+12	114.96%
Iran	78143644	75.389	5442.87	8.90E+11	9501.98	7.43E+11	174.58%
Israel	8215700	82.154	37582.80	4.25E+11	23237.01	1.91E+11	61.83%
Italy	60789140	82.690	35365.03	3.09E+11	24945.24	1.52E+12	70.54%
Jamaica	2720554	75.654	5108.36	2.15E+12	9839.72	2.68E+10	192.62%
Japan	127131800	83.588	38139.40	1.39E+10	28087.94	3.57E+12	73.65%
Kenya	44863583	61.576	1368.49	3.58E+10	1530.25	6.87E+10	111.82%
South Korea	50423955	82.156	27989.28	6.14E+10	23243.75	1.17E+12	83.04%
Laos	6689300	66.117	1754.90	1.41E+12	2789.18	1.87E+10	158.94%
Madagascar	23571713	65.086	452.81	1.17E+10	2433.55	5.74E+10	537.43%
Mexico	125385833	76.722	10353.48	1.07E+10	11332.35	1.42E+12	109.45%
Morocco	33921203	74.016	3239.30	1.30E+12	7924.51	2.69E+11	244.64%
Myanmar	53437159	65.858	1227.14	1.10E+11	2695.11	1.44E+11	219.63%
Norway	5137232	81.751	97005.55	6.56E+10	22033.05	1.13E+11	22.71%
Peru	30973148	74.526	6490.17	4.98E+11	8476.59	2.63E+11	130.61%
Philippines	99138690	68.266	2873.09	2.01E+11	3705.25	3.67E+11	128.96%
Russia	143819569	70.366	14273.51	5.45E+11	4891.01	7.03E+11	34.27%
Saudi Arabia	30886545	74.337	24406.49	2.05E+12	8268.17	2.55E+11	33.88%
Singapore	5469724	82.646	56007.21	7.54E+11	24800.87	1.36E+11	44.28%
South Africa	54058647	57.182	6498.59	3.06E+11	855.99	4.63E+10	13.17%
Spain	46480882	83.078	29718.45	3.51E+11	26257.47	1.22E+12	88.35%
United Kingdom	64613160	81.056	46412.06	7.99E+11	20098.57	1.30E+12	43.30%
United States	318907401	78.941	54539.66	3.00E+12	15196.94	4.85E+12	27.86%
Vietnam	90728900	75.629	2052.32	1.74E+13	9808.04	8.90E+11	477.90%

Table 3. Differences between GDP and HGDP as the criterion of social development

Scenario	GDP as the criterion	HGDP as the criterion ^{#1}	REE
GDP increases and HGDP increases	Social progress	Social progress	Unknown
GDP increases and HGDP declines	Social progress	Social retrogression	Decline
GDP declines and HGDP declines	Social retrogression	Social retrogression	Unknown
GDP declines and HGDP increases	Social retrogression	Social progress	Increase

^{#1} The judgments using HGDP are based on the assumption that what the relevant people were affected in the relevant period by the past were largely as valuable as what they did that period for the future.

Table 4. The top 20 countries in 2010 in terms of HGDP (regressed per the year 2010, and GDP or HGDP are in current USD)

Country / Region	Population	LE	GDP	HGDP
China	1.34E+09	75.007	6.10E+12	1.21E+13
United States	3.09E+08	78.541	1.50E+13	4.46E+12
India	1.23E+09	66.506	1.66E+12	3.61E+12
Japan	1.28E+08	82.843	5.70E+12	3.26E+12
Germany	8.18E+07	79.988	3.42E+12	1.43E+12
Brazil	1.99E+08	73.264	2.21E+12	1.42E+12
France	6.50E+07	81.663	2.65E+12	1.42E+12
Italy	5.93E+07	82.037	2.13E+12	1.36E+12
Mexico	1.19E+08	76.027	1.05E+12	1.23E+12
Britain	6.28E+07	80.402	2.43E+12	1.16E+12
Spain	4.66E+07	81.627	1.43E+12	1.01E+12
South Korea	4.94E+07	80.551	1.09E+12	9.29E+11
Indonesia	2.42E+08	68.147	7.55E+11	8.81E+11
Vietnam	8.69E+07	74.990	1.16E+11	7.84E+11
Canada	3.40E+07	81.413	1.61E+12	7.16E+11
Bangladesh	1.52E+08	70.080	1.15E+11	7.14E+11
Iran	7.43E+07	73.983	4.68E+11	5.86E+11
Turkey	7.23E+07	74.091	7.31E+11	5.79E+11
Russia	1.43E+08	68.856	1.52E+12	5.72E+11
Thailand	6.67E+07	73.694	3.41E+11	5.06E+11

Table 5. The top 20 countries in 2014 in terms of HGDP (regressed per the year 2010, and GDP or HGDP are in current USD)

Country / Region	Population	LE	GDP	HGDP	GDP increased by ^{#1}	HGDP increased by ^{#1}
China	1.36E+09	75.782	1.05E+13	1.37E+13	72.13%	13.22%
United States	3.19E+08	78.941	1.74E+13	4.85E+12	16.00%	8.74%
India	1.30E+09	68.014	2.04E+12	4.64E+12	22.89%	28.53%
Japan	1.27E+08	83.588	4.85E+12	3.57E+12	-14.91%	9.51%
Germany	2.06E+08	74.402	2.42E+12	1.72E+12	13.45%	21.13%
Brazil	6.65E+07	82.373	2.84E+12	1.59E+12	9.50%	11.97%
France	8.10E+07	80.844	3.88E+12	1.58E+12	7.17%	10.49%
Italy	6.08E+07	82.690	2.15E+12	1.52E+12	0.94%	11.76%
Mexico	1.25E+08	76.722	1.30E+12	1.42E+12	23.81%	15.45%
Britain	6.46E+07	81.056	3.00E+12	1.30E+12	23.46%	12.07%
Spain	4.65E+07	83.078	1.38E+12	1.22E+12	-3.50%	20.79%
South Korea	5.04E+07	82.156	1.41E+12	1.17E+12	29.36%	25.94%
Indonesia	2.54E+08	68.888	8.90E+11	1.02E+12	17.88%	15.78%
Vietnam	1.59E+08	71.626	1.73E+11	9.19E+11	60.34%	28.71%
Canada	9.07E+07	75.629	1.86E+11	8.90E+11	10.56%	13.52%
Bangladesh	3.55E+07	81.957	1.78E+12	8.05E+11	50.43%	12.43%
Iran	7.81E+07	75.389	4.25E+11	7.43E+11	-9.19%	26.79%
Turkey	7.75E+07	75.164	7.99E+11	7.15E+11	9.30%	23.49%
Russia	1.44E+08	70.366	2.05E+12	7.03E+11	34.87%	22.90%
Thailand	6.77E+07	74.422	4.04E+11	5.66E+11	18.48%	11.86%

^{#1} The data were calculated as compared with their counterparts of the year 2010.

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