AN OVERVIEW ON POVERTY GAP: A RESEARCH OF 38 COUNTRIES IN 2018

30th Jan 2022

Nguyen Phan Hong Ngoc – Research Analyst

Table of Contents

INTRODUCTION 2
DESCRIPTIVE ANALYSIS AND PROBABILITY 3
Probability testing 3
Descriptive Analysis 5
CONFIDENCE INTERVAL 7
Calculation of confidence interval 7
Assumption regarding calculation 8
Discussion on the results of confidence interval 8
HYPOTHESIS TESTING 9
Hypothesis approach 9
Discussion on the results of hypothesis testing if the dataset is doubled 11
CONCLUSION 12
REFERNCE LIST 0

INTRODUCTION

World Bank Development Research Group states that the poverty gap indicator is to measure the poverty through calculations on household income per capita and their consumption (Liberto 2021). This metric helps economist of developing countries to precisely measure the effectiveness of alleviating poverty programs to better guide the strategy in the rapid-pace economic level. However, setting the global poverty line is demanding since price level vary greatly among countries. (Roser & Ortiz-Ospina 2013; World Bank 2021)

The proportion of the world's population living in extreme poverty declined from 10.1% in 2015 to 9.3% in 2017. As a result, the number of individuals living on less than $1.90 per day has decreased from 741 million to 689 million (United Nations n.d.). 700 million people struggle surviving less than $1.09 per day and miserably, more than 1 billion children are living in harsh conditions with lack of necessities and 365 million children try to get through extreme poverty; all compared to 2.2 billion children existing on earth (Humanium n.d.; UNICEF n.d.). The statistics are not involved in the pandemic context, since the pandemic outbreak has made the size of poor grown, especially in the Southern Asia. Additionally, today, young people and family with children have live in extreme poverty compared to pensioner in the mid-1980s. Therefore, the 2030-year-plan of eradicating poverty is disrupted (United Nations n.d.). The poverty index not solely describes the number of the poor globally, consensus on the relationship between poverty and the inequality is recorded, thereby, policy research indicates that poverty reduction’s pace relies on the rate of average income growth, the inequality along with its shift. OECD additionally declares that the most primary element over painful decreasing economic level is the growing disparity between lower middle-class and poor households and the rest of society. (Bourguignon 2004; OECD 2014)

Gross National Income (GNI) corresponds with the GDP and the equality of income. Therefore, the metric is also relevant to the poverty gap. GNI is GDP adding up with net income from foreign countries such as compensation, property income or taxes on production and imports (Cheng 2021). Hence, GNI and GDP display additive association, and both calculate on per capita. Therefore, low GNI implies the same trend for GDP illustrating the economy is not actually producing and does not wealth the country whereas the income is low (OECD 2014). To other extent, when the GNI exceeds the GDP, that country receives more foreign aid helping

narrow down the poverty gap and eliminating the income inequality since this disparity is a thread to social cohesion and distresses the long-term economic growth (Chong, Gradstein & Calderon 2009)

Overall, this paper covers an examination of poverty rate across 38 sampled nations in one year-2018 with distinct economic position and GNI is also here to support the inferential statement. Throughout the work, conditional probability and descriptive statistics are calculated for categorizing the trend from low to high gross savings of the sample. The global poverty gap and assuming adjustment is made to the assigned sample size are approached by the confidence interval. Hypothesis testing is also utilized for concreting the confidence level.

DESCRIPTIVE ANALYSIS AND PROBABILITY

Probability testing

a. Data classification

38 participants are categorized mainly into 3 main sections accordingly to the poverty gap ratio and GNI index:

- Low gross savings countries (LS): *GNI < 20%*
- Medium gross savings countries (MS): *20% < GNI < 30%*
- High gross savings countries (HS): *GNI > 30%*

Poverty gap rate (PVR) also helps the classification more detailed. Countries would be defined as “High poverty gap” if their PGR exceeds 1, on the other hand, “Low poverty gap” label is for country with PGR levels below 1.

	High Poverty Gap Rate (HPV)	**Low Poverty Gap Rate (LPV)**	**TOTAL**
LS	3	5	8
MS	1	21	22
HS	1	7	8
TOTAL	5	33	38

Table 1. Contingency data table of various economic level countries with intensity of poverty gap

b. Statistically independent test

Reckoning the probabilities between gross savings and poverty gap illustrates the link of these two events whether they are distinct or relevant.

- Probability of countries with high PGR is denoted by *P (LPV)*
- Conditional probabilities of nations with high poverty rate, *P (LPV|HS); P (LPV|MS)* and *P (LPV|LS).*

$P\ (LPV) = \frac{LPV}{TOTAL} = \frac{33}{38} = 87\%$

$P\ (LPV|HS)\ \frac{P(LPV\ and\ HS)}{P\ (HS)} = \frac{7}{8} = 88\%$

⇨ ***P (LPV) ≠ P (LPV|HS)***

$P\ (LPV|MS) = \frac{P\ (LPV\ and\ MS)}{P\ (MS)} = \frac{21}{22} = 95\%$

⇨ ***P (LPV) ≠ P (LPV|MS)***

$P\ (LPV|LS) = \frac{P\ (LPV\ and\ LS)}{P\ (LS)} = \frac{5}{8} = 63\%$

⇨ ***P (LPV) ≠ P (LPV|LS)***

In the company of three preceding calculation, the dependency is detected since the probability of PGR does not equate the conditional probability of countries with different levels of earning. This drives the conclusion of statistically dependent occurrences between PGR and GNI. In other words, the national income and the poverty gap rate have a reciprocal relationship towards each other, they mutually impact on the outcomes.

To provide the most accurate likelihood of which countries have the highest PVR, probabilities can be utilized:

P (LPV|MS) > P (LPV|HS) > P (LPV|LS)

In contrast, the lower poverty rate tends to occur more in High and Medium Gross Savings nations compared to that of the low-income nations, 88%, 95% and 63%, respectively. As mentioned above, there is a relation between poverty gap and the economic growth, nations which control the poverty line at below 1 have higher probability to earn more and perform

better in respects of economic development. Evidently, high, and medium-income nations could narrow down the poverty gap.

Descriptive Analysis

a. Measure of Central tendency

CENTRAL TENDENCY OF POVERTY GAP IN DIFFERENT ECONOMIC-LEVEL COUNTRIES			
Types	**LS**	**MS**	**HS**
Mean	0.8	0.4	0.3
Mode	2	0.2	0
Median	0.4	0.2	0.1

Table 2. Contingency data table of central tendency in different economic-level countries' poverty gap rates.

	Lower threshold	< > =	Minimum value	Maximum value	< > =	Upper threshold	Result
LS	-2.425	<	0.0	2.00	<	4.375	No outlier
MS	-0.800	<	0.0	1.80	>	1.60	1 upper outlier
HS	-0.263	<	0.0	1.70	>	0.438	1 upper outlier

Table 3. Table of outlier identification in LS, MS, and HS countries' poverty gap rates.

Even though extreme values are detected in both MS and HS countries, **Mean** is still the most important measurement since it covers all the value, thereby providing more general picture of poverty gap rates. Within the sample size of 38 nations participating, LS countries have the highest mean rates, next came MS and then HS. Despite having no outlier defined, LS still values the highest mean rate because considerable values spread widely. The only one outlier detected in MS and HS countries is 1.6 and 1.7, respectively. Meanwhile, the PGR from LS countries is founded at 1.3 and 2.0, that drives no outliers detected. The implication behind this is also relevant to the preceding probability founded. Low rates tend to happen more in MS and HS countries therefore, the probability of high rates is rare making the 1.8 is extreme to MS countries but normal to LS countries. To reinforce the statement, **Median** is applied whenever outlier is detected since extreme value makes no effect on the results within this measurement. The result illustrates that the median of PGR in LS countries is larger than MS then HS (0.4 >

0.2 > 0.1). Overall, this section's calculation supports the idea of the direct impacts of poverty gap on economic growth. The higher PGR is, the lower savings countries earn. And to live under the low threshold can be considered as 'extreme poverty' (Roser & Ortiz-Ospina 2013)

b. Measure of Variation

VARIATION IN POVERTY GAP RATE			
Types	**LS**	**MS**	**HS**
Range	2.0	1.8	1.7
Interquartile Range	1.7	0.6	0.175
Variance	0.718	0.177	0.336
Standard Deviation	0.848	0.421	0.580
Coefficient of Variation	108%	105%	211%

Table 4. Contingency data table of variation in different economic-level countries' poverty gap rates.

Regarding the variation practice, Variance and Standard Deviation witness quite similar contrast structure, LS is larger than HS then MS, 0.718 > 0.336 > 0.177 in term of Variance and 0.848 > 0.336 > 0.177 in term of Standard Deviation. Since the gap between MS and HS is yet noticeable to that of between MS or HS and LS. Because in LS countries, the total value of PGR is larger than the other two due to higher value of PGR appears with higher intensity and probability. This answers why the variance and standard deviation of LS is more considerable to MS and HS. And since the mean is well-analyzed, Coefficient of Variation (COV) is also applied since it covers all the value. The higher COV reaches, the more drastically the value fluctuate far away the mean (Gordon 2021), this applies to HS countries whereas the COV is 211%, doubling that of LS countries. In other words, it is not a norm to witness a country with high savings but also high poverty gap rate.

CONFIDENCE INTERVAL

Calculation of confidence interval

This section navigates the Confidence interval calculation assuming the significance level (α) is at 5%, consequently the confidence level is 95% following the equation: (1- α) x 100%.

	Symbol	Value	Unit
Significance level	α	5	%
Confidence level	(1- α) x 100%	95	%
Sample mean	$\bar{X}$	0.455	% Poverty gap $3.20 per day
Sample size	n	38	Countries
Sample standard deviation	S	0.577	% Poverty gap $3.20 per day
Population standard deviation	δ	Unknown	

Table 5. Statistics summary of PGR

Central Limit Theorem (CLT) is practiced determining this dataset's distribution. The sample size of 38 values satisfies the CLT condition (n=38 > 30), thereby the sampling distribution is normal distribution. And since the population standard deviation is unknown, sample standard deviation takes over the role and the Students' t table is chosen for alternative calculation.

Degrees of freedom: d.f = n-1= 37

Level of significance: α = 0.05

⇨ t = 2.0267 (two-tailed test)

Confidence Interval Equation:

$$\boldsymbol{\mu = \bar{X} + t(\frac{S}{\sqrt{n}})}$$

⇨ $\boldsymbol{\mu = 0.455 \pm 2.026\ (\frac{0.577}{\sqrt{38}})}$

⇨ $\boldsymbol{0.265 \leq \mu \leq 0.645}$

Explanation: From recent assumption and calculation, it is 95% confident to state that the world average of poverty gap is between 0.265 and 0.645. From this calculated interval, policy maker and the countries government can assume that the global economy is producing efficiently enough to make the poverty gap below 1%. Moreover, maintaining the poverty gap rate to fluctuate around this interval reduces distress towards economic growth.

Assumption regarding calculation

As can be seen from the calculation, the application follows the Central Limit Theorem (CLT) since the population standard deviation remains unknown. Additionally, the dataset' sample size is 38 exceeding over the CLT's criteria at 30. Therefore, the component of algorithm is insufficient to propose an assumption excepting that the data follows the CLT and proves to be normally distributed.

Discussion on the results of confidence interval

In case the world standard deviation of PGR is acknowledged given the population mean is also able to calculate. Therefore, if the hypothesis is practiced, the primary calculation components are sufficient then Z-table is employed instead of the t-table. And this raises the precision of confidence level since the larger the sample, here is a population, the lower standard error and sample standard deviation provokes uncertainty to statistical work compared to population-related calculation (Anderson 2014; Malato 2021). Confidence level, in untechnical explanation, is determined by how closed the estimate is to the mean of a population. Although sample is still acceptable to identify an estimated interval, the precision is limited. To be straightforward, the more information and value can be gathered, the more precise the estimate point is, and confidence level thereby accelerates and narrows down the interval closest to the true value (Littler n.d.). The figure below is a graphical example for increasing the sample size and best to utilize the population for reducing the uncertainty in estimation process.

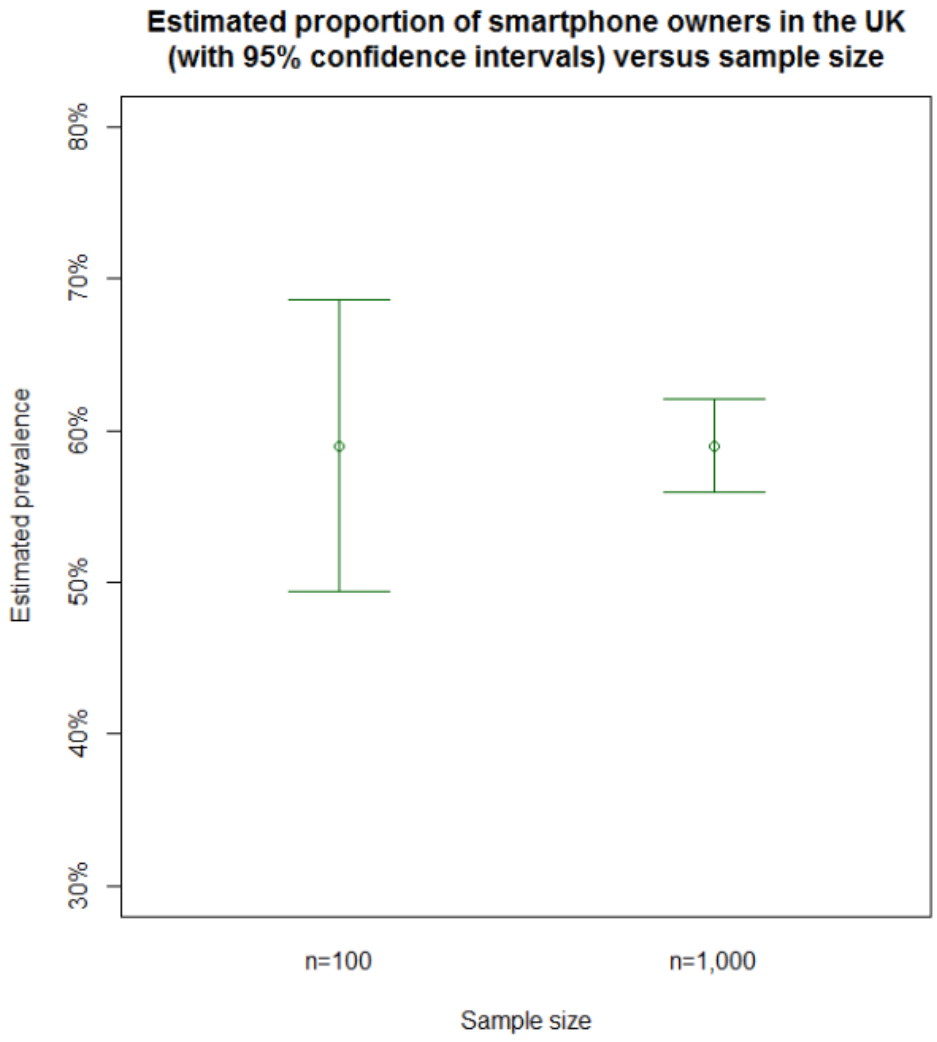

Figure 1. Reproduced from Select Statistics UK.

HYPOTHESIS TESTING

Hypothesis approach

World Bank once reported that the world poverty gap at $3.20 per day (2011 PPP) back in 2016 is 8.5%. Together with the confidence interval result of poverty gap from the dataset in 2018 in Part III ($0.265 \leq \mu \leq 0.645$). Applying this estimate point into 2016 mean, the PGR witnesses a dramatical decrease, and it may reduce in the future since the 2016 poverty gap is even lower than the lower threshold of confidence interval. To uphold this assertation, Hypothesis Testing is here to prove.

	Symbol	Value	Unit
Significance level	α	5	%
Confidence level	(1- α) x 100%	95	%
Sample mean	$\bar{X}$	0.455	% Poverty gap $3.20 per day
Sample size	n	38	Countries
Sample standard deviation	S	0.577	% Poverty gap $3.20 per day
Population standard deviation	δ	Unknown	
Population mean (2016)	μ	8.5	% Poverty gap $3.20 per day

Table 6. Statistics summarization of PGR

Step 1: Test the Central Limit Theorem (CLT)

The sample size satisfies the CLT criteria of being above 30 (n=38) then the sample follows normal distribution.

Step 2: Construct hypothesis

Null hypothesis: $H_0 \leq 8.5$

Alternative hypothesis: $H_1 > 8.5$

Step 3: Adopt table

T-table is still employed because of lacking the population standard deviation and the sample also follows normal distribution.

Step 4: Sort out testing

According to the preceding hypothesis construction, "≤" in alternative hypothesis is a sign to pick out one-tailed test (lower-tailed).

Step 5: Determine the critical value

Degree of freedom: d.f = n-1 = 38-1 = 37

Significance level α = 0.05

⇨ t = -1.687 (lower tail)

Step 6: T-test

$$t' = \frac{\bar{X} - \mu}{\frac{S}{\sqrt{n}}} = \frac{0.455 - 8.5}{\frac{0.577}{\sqrt{38}}} = -85.949$$

Step 7: Compare critical value and test statistics

t' < t (-85.949 < -1.687), the test statistics is in the Rejection area, therefore H_0 is rejected.

Step 8: Reflect the result to real-life practice

It is 95% confident to assert that H_0 would be rejected which means the PGR is 95% certain to decrease in the future. This brings good news to the government and authorization since the poverty gap decreases proving positive development and well-grown production.

Step 9: Evaluate possible type of errors

When the rejection of null hypothesis is recognized, Type I error tends to happen. Although Type I error is more serious than Type II error, the probability for Type I error to occur could be brought under control depending on the preferences or here in the context of global poverty rate, it depends on how the policy advocates towards reducing the rate to the possible minimum rate generating least obstacles to economic development.

Discussion on the results of hypothesis testing if the dataset is doubled

If the sample size is doubled (n=76), the degree of freedom would follow the same trend pattern (d.f = 75). Within this circumstance, the further information is gathered, the more precise confidence interval could be. By this, the rejection area is scaled down making a shift to the type of errors may occur; from type I to type II. To minimize the occurrence of type II error in this case, doubling the sample size is the most appropriate method to drive the hypothesis testing more accurately. Type II navigates towards the change in statistical power which is defined as the probability that the test comprehensively rejects the null hypothesis (Brownlee 2018). And

increasing the number of samples is the best method to shrink the power of the test since the probability of failing to reject null hypothesis increases.

CONCLUSION

To conclude, this paper consists of 4 dominant findings through the sample size of 38 participating countries concerning the poverty gap rates. Overall, the number of countries with low poverty gap rates dominates countries with high rates implicating that within this sample, the economic levels are generally productive and not in somewhat of recession or downturn.

First, probability calculation indicates that the GNI and PGR statistically related. The technique's implication is to illustrate that one event affects the national income then it would pay a toll on the poverty gap rate and vice versa. Furthermore, the calculation also demonstrates that High, and Medium gross savings countries could best maintain the poverty rate at acceptable rates that least hamper their domestic economic levels. As proof, higher probability of low PGR concentrates at these countries, 88% and 95%, respectively. And in low gross savings countries, it is a norm to witness high rates among these countries with 63%.

Next, the descriptive measures of three-segmented countries emphasize the inverse relationship between the earnings and the poverty index. Since low PGR implies HS countries, therefore exception happens when one HS country exceeds the poverty gap rate. Conversely, in LS countries with high PGR making it no extreme value detected and the total value is also high with diverse value of PGR dragging the variation up higher than the MS and HS countries. This concretes the assumption of a norm in LS countries previously.

Third, the confidence interval calculation allows readers to acknowledge 95% the population mean would fall within the interval of 0.265% and 0.645% of poverty gap at $3.20 per day. And when World Bank published the global poverty gap at 8.5% back in 2016 falling out of the non-rejection area accordingly to the Hypothesis testing. This means that the percentage would keep decreasing in the future as a good sign to any economies.

All in all, the poverty gap rate report plays a critical role in monitoring how the poor are earning below the poverty line and how the government are facilitating for them to upgrade their living standards to get rid of harsh living-conditions aligning the 'No poverty' is the United Nations SDG 1(United Nations n.d.). Since the relationship between the savings countries made

significantly impact the poverty gap rate, and the global rate are decreasing like a sharp decrease of mean global rate from 2016 to 2018. Although, type I error have higher probability to incur in the calculation process, the probability could be brought under control. Besides narrowing the gap, it is essential for countries to enhance or vary their sources of income since these two metrics affect each other back and forth. Lastly, in a larger-scale statistics, it requires more significant work and information from all the countries around the world for best precision and assumption since all the calculation for this report's hypothesis is utterly based on the sample of 38 countries, therefore, it is not applicable to demonstrate global assumption.

REFERNCE LIST

Anderson, A 2014, 'Business statistics for dummies', John Wiley & Sons, Inc., NJ.

Bourguignon, F 2004, The-Poverty-Growth-Inequality triangle, company report, ICRIER, no.125

Brownlee, J 2018, *A Gentle Introduction to Statistical Power and Power Analysis in Python*, Machine Learning Mastery, viewed 23 April 2022, < https://machinelearningmastery.com/statistical-power-and-power-analysis-in-python/#:~:text=a%20false%20positive.-,What%20Is%20Statistical%20Power%3F,the%20null%20hypothesis%20is%20rejected.>

Cheng, M 2021, *Gross National Income (GNI),* Investopedia, viewed 20 April 2022, < https://www.investopedia.com/terms/g/gross-national-income-gni.asp#:~:text=GDP%20is%20the%20total%20market,in%20the%20country%20or%20abroad. >

Chong, A, Gradstein, M & Calderon, C 2009, 'Can the foreign aid reduce the income inequality and poverty?', *Public Choice,* vol.140, pp-59-84.

Gordon, J 2021, 'Coefficient of Variation – Explained', *The Business Professor*, 20 July, viewed 18 April 2022, < https://thebusinessprofessor.com/en_US/research-analysis-decision-science/coefficient-of-variation-definition>

Humanium n.d., 'Children in the world', *Humanium,* viewd 20 April 2022, <https://www.humanium.org/en/children-world/#:~:text=Today%2C%20there%20are%20more%20than%202.2%20billion%20children%20on%20Earth.>

Liberto 2021, *Poverty Gap*, Investopedia, viewed 22 April 2022, < https://www.investopedia.com/terms/p/poverty-gap.asp>

Littler, S n.d., The Importance and Effect of Sample Size, blog, viewed 23 April 2022, <https://select-statistics.co.uk/blog/importance-effect-sample-size/>

Malato, G 2021, *How accurate is your accuracy*, TowardsDataScience, viewed 23 April 2022, <https://towardsdatascience.com/how-accurate-is-your-accuracy-d420f903bbae>

OECD 2014, 'Inequality hurts economic growth, finds OECD research', *OECD*, viewed 21 April 2022, <https://www.oecd.org/newsroom/inequality-hurts-economic-growth.htm>

Roser, M & Ortiz-Ospina, E 2013, Global Extreme Poverty, company report, Our World in Data, viewed 22 April 2022, < https://ourworldindata.org/extreme-poverty>

UNICEF n.d., 'Child poverty', *UNICEF*, viewed 20 April 2022, <https://www.unicef.org/social-policy/child-poverty>

United Nations n.d., 'End poverty in all its forms everywhere', *United Nations*, viewed 21 April 2022, < https://unstats.un.org/sdgs/report/2021/goal-01/ >

World Bank 2021, 'Measuring Poverty Overview', *World Bank*, viewed 20 April 2022, < https://www.worldbank.org/en/topic/measuringpoverty#1>