

Small Area Estimation of Underemployment in the Bicol Region Using Model-Based Approach

ABSTRACT

The Philippines remains to have a declining unemployment rate through the years. Although this progress exhibits a positive vision in the economy of the country, this does not equate towards an inclusive growth where poverty alleviation is accomplished. In recent times, underemployment, which is defined as the measure of employed persons who express the desire to have additional hours of work in their present job or an additional job, or to have a new job with longer working hours, has been recognized as an important indicator in measuring the growth of the economy. By determining smaller areas that have relatively high underemployment rate may be relevant for policy-makers to provide programs that would generate sufficient and suitable employment opportunities for many Filipinos, particularly in the Bicol Region which continues to have a relatively high underemployment rate compared with the other regions. In 2018, the underemployment rate in the Bicol Region was estimated at 29.6 percent, surpassing the national underemployment rate of 16.4 percent based from the 2018 Annual Labor and Employment Estimates of the Philippine Statistics Authority (PSA). Thus, this paper aims to present the results of a study that generates the city and municipal level underemployment statistics of the Bicol Region and use the statistics to assess the underemployment conditions in the region for year 2015. In generating the city and municipal level statistics, an indirect small area estimation (SAE) technique was employed which follows a model-based approach. The city and municipal level estimates of the Bicol Region were generated using the EBLUP of the Fay-Herriot methodology while integrating geo-spatial information into the model. The 2015 Labour Force Survey (LFS), 2015 Census of Population (PopCen), Barangay Listing (BL) and administrative data sets of the region were the data sources for this study. Areas with high underemployment rate were identified wherein programs can be implemented to help them.

Keywords: small area estimation, spatial analysis, underemployment, EBLUP

I. INTRODUCTION

The Philippines has been sustaining slow economic growth in recent years which has been gradually translating into an increasing trend of the employment rate. According to World Bank, the primary factor for a sustainable and inclusive growth is assumed to be full and productive employment [1]. While employment growth is one of the indicators closely monitored by policy makers to measure the economic activity of the country, continuously progressing quality of work can gauge if the economic growth has the capacity to increase daily wages and improve the living condition of the low-income earners.

In 2015, the Philippines committed to achieve the Sustainable Development Goals (SDGs), which includes the *Goal 8 – Decent Work and Economic Growth* that promotes sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, a country's economic growth must lead towards new and better employment opportunities and provide greater economic security for all [3]. However, persistently high inequality of incomes and weak employment generation of a country are one of the few factors that hinders inclusive growth. It was observed that labor productivity, especially in developing countries, remains far below from developed regions despite improvements and on-going efforts.

Among the many low-income countries, the recurring problem on employment shifted from unemployment to underemployment. Unlike unemployment which mainly affects the youth, underemployment cuts across age and sex groups and is particularly pronounced among the less educated workforce and in regions where agriculture is the dominant sector. [4] It can be generally

observed that in most developing countries where there are inadequate support programs for the unemployed, workers tend to engage in any activity. This is a status of a worker where the worker is employed in a job that may not match his/her job preferences. A worker may have an experience in a certain field but because they cannot afford to stay unemployed the worker is compelled to be employed in a job that does not suit the worker's preference. This results to a high proportion of individuals who engage in alternative employment activities which generate a lower income, rather than face unemployment. Statistics indicate that in the Philippines underemployment rate remained high and exhibited more volatility than unemployment rate fluctuating between the range of 17.9% (July 2010) to 22.8% in July 2012 to 13.9% (July 2019). Past studies have also shown that poverty in the Philippines is more correlated with the problem of underemployment than unemployment. The 2015 poverty incidence among the basic sectors [5] presented that the poverty incidence is higher among employed (18.0%) than among the unemployed (16.4%).

Thus, it is important to use underemployment as a measure of labor underutilization to complement unemployment rate in signaling situations of insufficient labor absorption among persons in employment with unmet need for work for pay or profit. This indicator generally captures similar groups of persons that share some characteristics with the unemployed but who are included in the statistics among the employed.

Currently, the PSA releases underemployment rate at the regional level due to the limitations of the survey data. This has become a constraint for policymakers who need to know and target the cities/municipalities particularly now that development plans are already localized. Determining smaller areas with relatively high underemployment rate may be relevant for policy-makers to provide programs that would generate sufficient and suitable employment opportunities for many Filipinos, particularly in the Bicol Region which continues to have a relatively high underemployment rate compared with the other regions. In 2018, the underemployment rate in the Bicol Region was estimated at 29.6 percent, surpassing the national underemployment rate of 16.4 percent based from the 2018 Annual Labor and Employment Estimates of the Philippine Statistics Authority (PSA) [6]. Thus, this paper aims to present the results of a study that generates the city and municipal level underemployment statistics of the Bicol Region. It also aims to investigate the link between underemployment geographical condition in Bicol Region.

Small area methods attempt to solve low representativeness of surveys within areas, or the lack of data for specific areas/subpopulations. This is done by incorporating information from other sources that are becoming increasingly available such as geospatial information produced using remote sensing. The strength of these target datasets is their granularity on the subpopulations of interest. The resulting estimates can be used as information support of both the government and the private sector to guide them in the allocation of national and local government funds as well as in national and local government level planning. This will also aid different government agencies such as the Department of Labor and Employment (DOLE) and the local government units in their employment generation strategies and in their convergence programs.

II. RESEARCH METHODOLOGY

Data Sources

This study utilized the survey data sets that came from the Labour Force Survey (LFS), Census of Population (PopCen), Barangay Listing (BL) and administrative data sets of the Bicol Region. Specifically, the 2015 LFS survey data sets, 2015 PopCen, and 2015 BL for the Bicol

Region were used while incorporating geo-spatial variables. Some administrative data sets were also utilized in the study.

The LFS is a nationwide survey conducted every quarter of the year, which is the major source of official employment data of the country. It also collects data on the demographic and socio-economic characteristics of population [7]. Using the LFS data on the household members can be generated, which includes the educational attainment of the working age population, average percentage of school children who are currently in school and the average percentage of working age population who are employed, household head's age, sex, marital status, highest educational attainment, employment status and occupation.

The PopCen is a complete enumeration of the population in the country and conducted as a mid-decade census. It gives information on the distribution of population and its characteristics of their housing units. The Barangay Listing in 2015 includes some characteristics for all the barangays in the country such as the existence of a market in the barangay, whether barangay is part of the city/municipal proper, accessibility of the barangay to a national highway, distance of the barangay to the city/municipal hall, among others.

The distance of the centroids of the cities/municipalities was extracted from the Official Philippine Map showing the city and municipal boundaries and centroids released by the National Mapping and Resource Information Agency (NAMRIA) using the GeoData 1.4.0.

In addition to the distance of the centroids of the cities/municipalities, the study also made use of spatially referenced variables describing capital city access, night time lights as a proxy indicator for economic activities and the rural access index measuring people's transport accessibility in rural area where majority of the poor lives.

Spatial Autocorrelation

To measure spatial autocorrelation of the underemployment, the Local Moran's I was generated. Given a set of features and an associated attribute, it evaluates whether the pattern expressed is clustered, dispersed, or random. The tool calculates the Moran's I Index value and both a Z score and p-value evaluating the significance of that index. In general, a Moran's Index value near +1.0 indicates clustering while an index value near -1.0 indicates dispersion.

Estimation

The city and municipal estimates of the underemployment rate in the Bicol Region will be generated using the direct estimation and model-based approach. Direct estimation is the most basic estimator and is appropriate to use when all the areas have been sampled. The direct estimate is obtained by getting the weighted underemployment rate for each sampled municipality. Since the samples do not cover all the municipalities of the Bicol Region, small area estimation methods such as the Empirical Bayes Linear Unbiased Prediction (EBLUP). The EBLUP is a linear combination of the small area direct estimator and a predicted component based on a linear mixed model. The model relates the parameter of interest to known auxiliary variables for each of the small area that constitute the partition of the whole population.. The auxiliary variables considered also included geo-spatial variables to account for the spatial characteristics of each small area.

In most cases, equivalence maybe achieved by collapsing some categories of answers and when common variables have been identified, the appropriate summary statistics are compared for the survey and census data. For variables to be considered as consistent, summary statistics for the census data should be within the confidence interval for the survey data.

The objective is to tailor the model to account for the geographic characteristics of the region and its cities and municipalities, such as spatial peculiarities. After model estimation, census data was fitted to the parameter estimates.

The assessment of candidate models for a region involved comparison of the similarity (a subset of) parameter estimates and similarity of small area estimates, in addition to basic statistical criteria such as adjusted R squares, among others. The model should also be simple and possess parameter estimates that are logical.

III. RESULTS AND DISCUSSIONS

A. Direct Estimates of the City/Municipal Level Underemployment Rate in Bicol Region

In 2015, the estimated national underemployment rate is 18.5% with an estimate of seven million members of the labor force population being underemployed. Based on the Annual Labor and Employment Estimates for 2015 of the PSA, Bicol was estimated to have 2.3 million employed labor force population. However, the region was also observed to have one of the highest incidences of underemployment across the regions, where one in every three individuals of the labor force is underemployed. The lack of lower disaggregated data on the employment indicators encourages the generation of sound estimates using model-based approaches.

In order to generate model-based underemployment estimates, direct estimates of the underemployment rate were generated at the city and municipal level. The estimates of the underemployment rate for each sampled cities and municipalities in Bicol were generated thru direct estimation using the 2015 LFS. Seventy-seven estimates were obtained from direct estimation for the region. The distribution of the city and municipal level estimates of underemployment rate using direct estimation is shown in Table 1. The estimates obtained ranged from 2.82% to 75.12% of the Municipality of Guinobatan (Albay) and Municipality of Mandaon (Masbate), respectively. Almost half of the underemployment estimates generated are between 20% to 40% (41.56%). Further, more than half of the estimates were observed to be unreliable with coefficients of variation being greater than 30%. It can be observed in Figure 1 that the Municipality of Calabanga, Camarines Sur and the Municipality of Mandaon, Masbate both obtained underemployment rate that were greater than 70%. Meanwhile, the Municipalities of Lupi and Sipocot from Camarines Sur, Santa Elena from Camarines Norte, Oas and Ligao City of Albay were observed to have underemployment rates greater than 60%, with most coefficients of variation being less than 20% making most of the estimates reliable.

Table 1. Distribution of the direct estimates of the underemployment rate

at the city and municipal level of Bicol Region (2015 LFS).

Estimates	Frequency	Percentage
At most 20	19	24.68
20.01 to 40.0	32	41.56
40.01 to 60.0	19	24.68
60.01 to 80.0	7	9.10
Greater than 80.0	0	-
Total	77	100

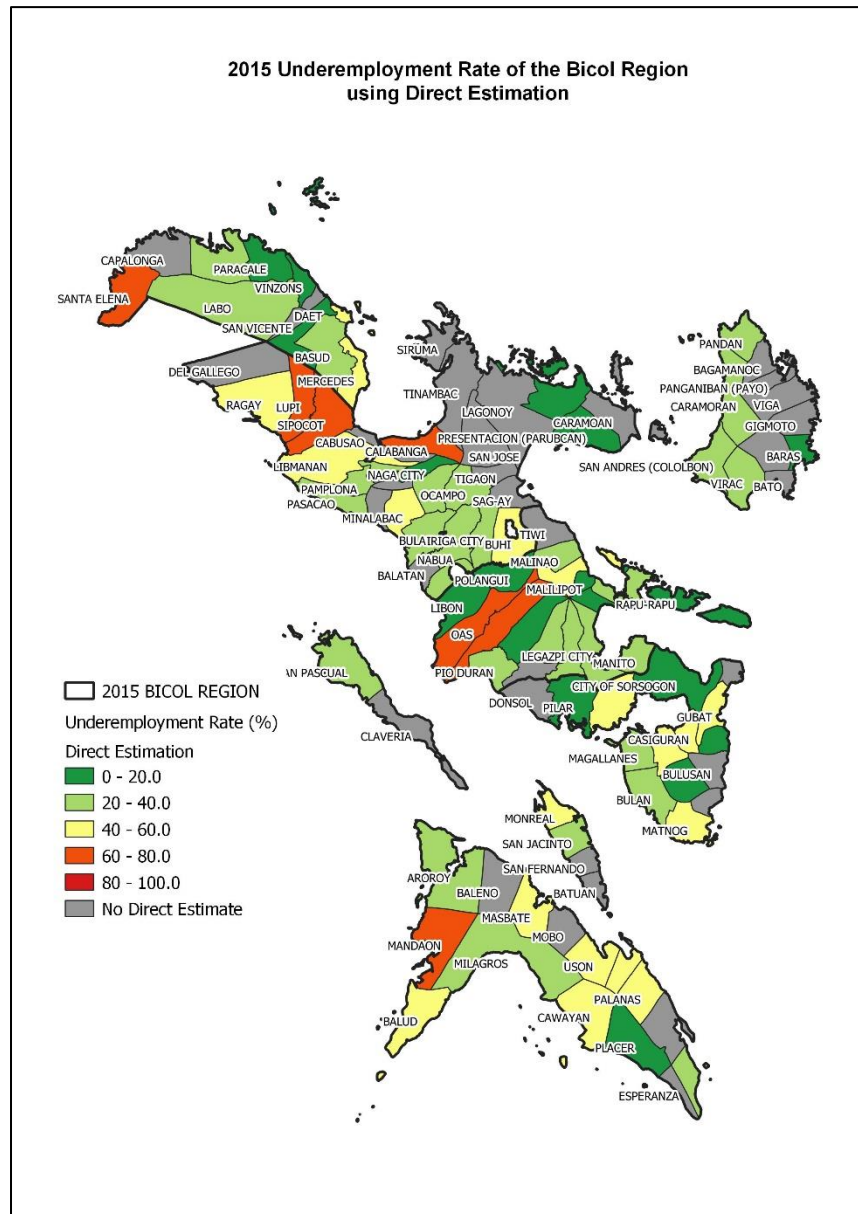


Figure 1. 2015 Underemployment Rate of the Bicol Region using Direct Estimation

B. Spatial Autocorrelation of Underemployment Rate in Bicol Region

Moran's I measures similarity or dissimilarity in a variable across neighboring spatial units. It captures the existence of a homogenous pattern of spatial association over the entire study area (Anselin, 1995). It evaluates whether the pattern expressed is clustered, dispersed, or random. A positive Moran's I index value indicates tendency toward clustering while a negative Moran's I index value indicates tendency toward dispersion. Centroid-to-centroid distance matrix was used which defined neighbors as those in Euclidean distance of centers of the cities and municipalities is less than or equal to a defined value.

It can be observed that the spatial correlation is negative, implying that there is dissimilar underemployment rate among the municipalities that cluster together.

Table 2. Measures of global spatial autocorrelation

Variables	Moran's I	E(I)	sd(I)	z	p-value*
Underemployment	-0.028	-0.013	0.008	-1.955	0.025

C. Model-based Estimates of the City/Municipal Level Underemployment Rate in Bicol Region

With the goal of generating city and municipal level underemployment incidences using a spatial model-based approach, a model-based small area estimation methodology was used to generate lower disaggregated estimates. The ELL methodology was initially identified to be used in generating small area estimates while packaging it as a spatial autoregressive model. However, upon investigation of the assumption and criteria of the methodology, it was determined that the data on underemployment was not appropriate for ELL since the methodology was created for poverty mapping which has different characteristics and determinants from the underemployment incidence. Although model-building was conducted using the ELL approach, the generated models were found to have no predicting power in generating underemployment estimates since the average of the generated R-squares was below 10%. Further, it was also determined that the underemployment is not spatially affected by its neighbors which was concluded from computing the Moran's I estimate.

In commitment to the objective of generating underemployment incidences at the city and municipal level, the Fay-Herriot Model Approach was used to generate the Empirical Best Linear Unbiased Prediction (EBLUP) for the underemployment rate. Considering the assumptions of the methodology, the model had five predictors (Table 3). The predictors were the (1) average number of barangays in the municipality/city with a large or significant numbers of families who moved to the barangay in the last five years (due to typhoon, natural disaster, or peace and order conflicts), (2) average number of laborers and unskilled workers in the municipality/city, (3) average number of barangays with a library in the municipality/city, (4) average number of barangays where a town/city hall or provincial capitol is located, and (5) average number of barangays with establishment(s) offering personal services (such as health spa, beauty parlor, barber shop, laundry shop, funeral parlor and other shops offering personal services activities). It can also be observed that all predictors are significant at 10% level and even the model as a whole was noted to be significant. The model had an Adjusted R-squared of 31.53% which describes that predictors of the model explains the 31.53% variation in the underemployment rate.

Table 3. Predictors of the model with their corresponding effect on the dependent variable and computed p-values.

Predictor	Coefficient	Standard Error	P-value
average number of barangays in the municipality/city with a large or significant number of families who moved to the barangay in the last five years (due to typhoon, natural disaster, or peace and order conflicts)	0.60	0.16	0.001
average number of laborers and unskilled workers in the municipality/city	-0.39	0.21	0.069
average number of barangays with a library in the municipality/city	-0.65	0.20	0.002
average number of barangays where a town/city hall or provincial capitol is located	-3.34	1.25	0.01
average number of barangays with establishment(s) offering personal services (such as health spa, beauty parlor, barber shop, laundry shop, funeral parlor and other shops offering personal services activities)	0.40	0.16	0.014
Constant	0.38	0.13	0.004

The distribution of the generated model-based estimates was observed to be lumped in the range of 20% to 40% where more than half of the municipality and city estimates are in between this range (Table 4). The EBLUP estimates computed ranged from 3.30% to 68.90% of the Municipality of Polangui (Albay) and Municipality of Mandaon (Masbate), respectively. More than 50% of the underemployment estimates generated are between 20% to 40% (55.26%). It can be observed in Figure 2 that there are no longer missing estimates. The only municipalities with underemployment rate greater than 60% were the Municipalities of Calabanga (Camarines Sur), Mandaon (Masbate), Sipocot (Camarines Sur) and Santa Elena (Camarines Norte) with coefficients of variation being less than 20% making the estimates reliable.

Table 4. Distribution of the EBLUP estimates of the underemployment rate at the city and municipal level of Bicol Region (2015 LFS).

Estimates	Frequency	Percentage
At most 20	23	20.18
20.01 to 40.0	63	55.26
40.01 to 60.0	24	21.05
60.01 to 80.0	4	3.51
Greater than 80.0	0	-
Total	114	100

The distribution of the coefficients of variation obtained from the direct and EBLUP estimation exhibited a shift (Table 5). More than fifty percent of the estimates obtained from the direct estimation were deemed to be unreliable since more than half of the coefficients of variation obtained were greater than 20%. On the other hand, almost 70% of the coefficients of variation obtained from the EBLUP were less than 20% implying that the estimates obtained were mostly reliable, implying that 78 out of the 114 resulting estimates are with acceptable measures of reliability.

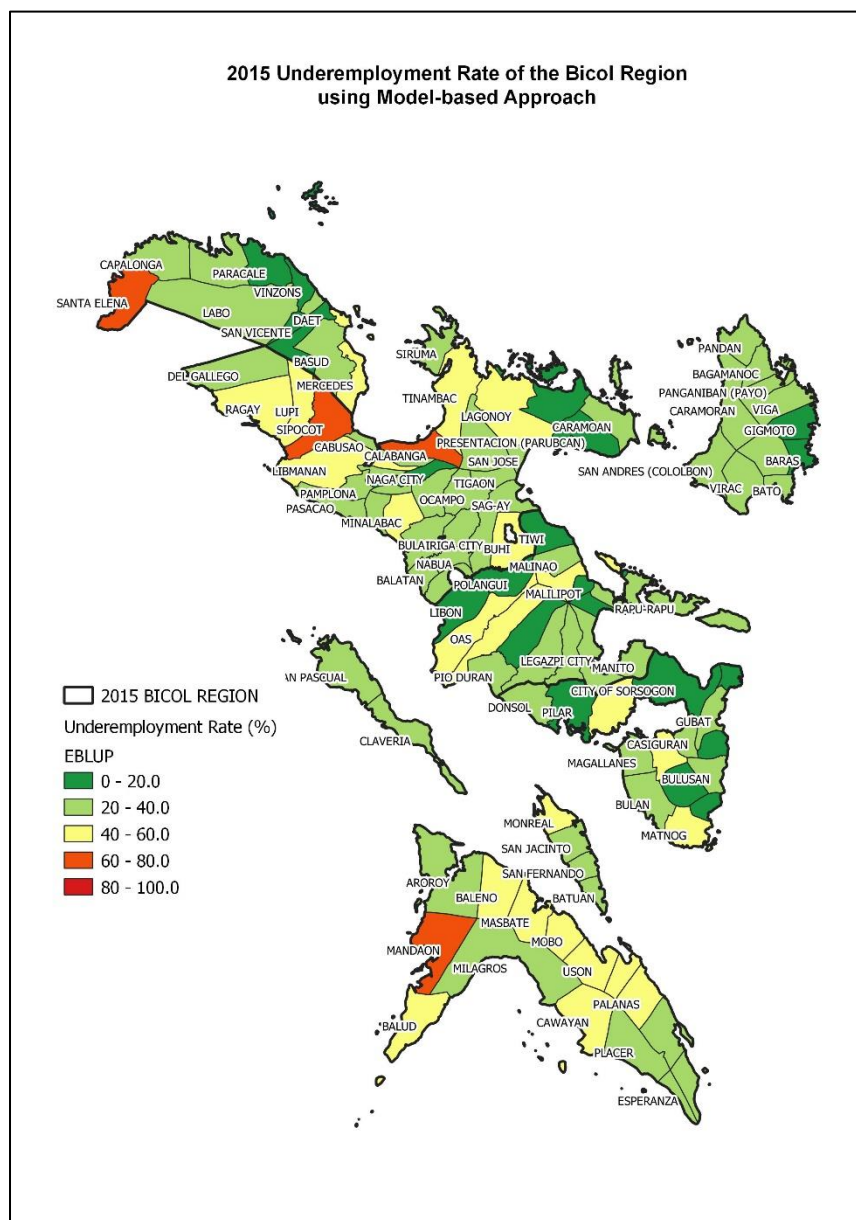


Figure 2. 2015 Underemployment Rate of the Bicol Region using EBLUP Estimation

Table 5. Distribution of the coefficient of variation of the estimates obtained using direct estimation and EBLUP estimation

Coefficient of Variation	Direct Estimation		EBLUP Estimation	
	Frequency	Percentage	Frequency	Percentage
At most 10.0	6	7.79	23	20.18
10.1 – 20.0	29	37.66	55	48.25
Greater than 20.0	42	54.55	36	31.58
Total	77	100	114	100

IV. CONCLUSIONS AND RECOMMENDATION

To provide lower disaggregated statistics on underemployment to aid policy makers and program monitoring, two small area estimation techniques were utilized to estimate the municipal and city level underemployment rate in the Bicol Region. These two are direct estimation and model-based estimation, specifically the EBLUP estimation. 2015 LFS survey data sets, 2015 PopCen, and 2015 BL for the Bicol Region were used while incorporating geo-spatial variables describing capital city access, night time lights as a proxy indicator for economic activities and the rural access index of the population near all season roads. With the objective of incorporating spatial variables in the model, it was also determined that the underemployment is not spatially dependent from its neighbors where the Moran's I estimate generated a negative value.

For estimating the underemployment, the 2015 LFS was used to generate direct estimates on the underemployment rate at the city and municipal levels for Bicol. Seventy-seven estimates were obtained from direct estimation. But only 35 out of 77 obtained direct estimates were considered reliable. Using the direct estimates obtained from 2015 LFS together with 2015 PopCen and Barangay Listings, estimates on the underemployment rate of each city or municipality were obtained through the EBLUP estimation approach. The 'best' fitted model has five predictors, namely; (1) average number of barangays in the municipality/city with a large or significant numbers of families who moved to the barangay in the last five years (due to typhoon, natural disaster, or peace and order conflicts), (2) average number of laborers and unskilled workers in the municipality/city, (3) average number of barangays with a library in the municipality/city, (4) average number of barangays where a town/city hall or provincial capitol is located, and (5) average number of barangays with establishment(s) offering personal services (such as health spa, beauty parlor, barber shop, laundry shop, funeral parlor and other shops offering personal services activities). With an adjusted R-squared of 31.53%, 78 out of 114 estimates obtained were with acceptable measures of reliability.

Both direct estimation and EBLUP estimation showed that the Municipality of Mandaon from Masbate remained to have the highest underemployment rate among the cities and municipalities in the region. However, based from the obtained standard errors and coefficients of variation, the EBLUP estimation technique was determined to produce more reliable estimates than the other direct estimation method. With the initial consideration of ELL, it would be best to explore and determine first the strong determinants of the underemployment. Further studies may be done to identify the correlates of underemployment. Since the ELL was initially created for poverty mapping, consultation with the experts of the methodology may be done to explore other indicators that the methodology could measure.

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