From Light to Growth: A Study of Night-Time Light as an Indicator of Economic Development*

Growth in Night-Time Light Intensity Correlates ____% With GDP Growth

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This study investigates the relationship between the growth of night-time light (NTL) intensity, as captured by satellite imagery, and GDP growth across countries over a multi-decade period. By analyzing data spanning from 1992 to 2001, we find a strong correlation of [X]% between NTL growth and GDP growth. Importantly, the strength of this correlation varies by the statistical capacity of countries. Countries with high statistical capacity, rated 'A' by the World Bank, exhibit a correlation as high as [X]%, while those with low statistical capacity, rated 'F', show a correlation as low as [Y]%. These findings highlight the potential of NTL data as a complementary tool for economic analysis, particularly in regions where conventional economic metrics are less reliable or unavailable.(Blank spaces will be filled when project is completed)

1 Introduction

2 Data

This study uses a harmonized global night-time light (NTL) dataset spanning from 1992 to 2018, developed by Li et al. This dataset integrates observations from two major satellite systems: the Defense Meteorological Satellite Program (DMSP)/Operational Linescan System (OLS) and the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership satellite. Night-time light data provide a unique proxy for human

*Code and data are available at: https://github.com/shamayla38/EconomyLightCorrelation.

activity, offering insights into economic development, infrastructure expansion, and population dynamics across regional and global scales.

The DMSP dataset, available from 1992 to 2013, captures night-time illumination but suffers from limitations such as coarser spatial resolution and saturation in brightly lit areas. The more recent VIIRS data, available from 2012 to 2018, addresses these issues with improved spatial resolution and sensitivity. However, the transition between DMSP and VIIRS introduces inconsistencies, making direct comparison across years challenging. To address this, the authors harmonized the datasets by inter-calibrating DMSP observations and simulating DMSP-like VIIRS observations, creating a globally consistent record of NTL intensity over time.

The harmonized dataset is distributed as a collection of GeoTIFF files, with each file representing annual NTL data for a given year. These files provide Digital Number (DN) values for each pixel, corresponding to the intensity of night-time illumination. For this study, we used the harmonized GeoTIFF files as the foundational data source, enabling robust analysis of the relationship between changes in NTL intensity and GDP growth across countries and years

2.1 Measurement

Nocturnal lighting, primarily from artificial sources like residential and industrial areas, serves as a key indicator of human activity. Night-time light (NTL) data, captured by the Defense Meteorological Satellite Program's Operational Linescan System (DMSP/OLS) and the Visible Infrared Imaging Radiometer Suite (VIIRS), provides a spatially explicit proxy for human presence. DMSP/OLS, operational since the 1970s, used low-light imaging to detect artificial lights but faced challenges like coarse resolution and sensor saturation (C. D. Elvidge et al. 1999). VIIRS, introduced in 2012, improved spatial resolution and dynamic range, using advanced algorithms to remove noise and non-anthropogenic light sources, resulting in high-quality radiance-calibrated maps (C. Elvidge et al. 2017). Both systems process raw radiance data into georeferenced Digital Number (DN) values, composited over time to ensure consistency and reduce noise. These datasets enable global-scale studies of socio-economic phenomena, such as population density, energy consumption, and economic activity, through the lens of artificial light intensity.

2.2 Data Extraction and Cleaning

The main task in preparing the dataset was the extraction of night-time light (NTL) intensity values from the GeoTIFF files. Using the `rasterio` package in Python, we processed annual TIFF files to extract Digital Number (DN) values, which represent the intensity of light, along with their corresponding latitude and longitude coordinates. This provided a spatial dataset that detailed the distribution of NTL intensity globally for each year.

To associate each observation with a specific country, the extracted data were merged with a global shapefile of country boundaries using spatial join techniques. Each latitude-longitude pair was assigned to the country in which it was located. Observations without an assigned country, primarily from international waters, were removed since they could not be attributed to a specific region and often represented ambiguous sources, such as ships or vessels.

The dataset had only four columns—latitude, longitude, DN, and country—so minimal cleaning was required. The primary cleaning step was to remove observations with missing country values. Finally, to create an aggregate annual measure of NTL intensity for each country, all observations within a country were summed to calculate the total light emitted annually. This resulted in a dataset where each row represented a country, and the sum of NTL intensity served as our primary independent variable. Each year's dataset thus provides a single measure of total NTL emitted by a country for that year, facilitating longitudinal analysis.

Elvidge, Christopher D, Kimberly E Baugh, John B Dietz, Theodore Bland, Paul C Sutton, and Herbert W Kroehl. 1999. "Radiance Calibration of DMSP-OLS Low-Light Imaging Data of Human Settlements." *Remote Sensing of Environment* 68 (1): 77–88. https://doi.org/https://doi.org/10.1016/S0034-4257(98)00098-4.

Elvidge, Christopher, Kimberly Baugh, Mikhail Zhizhin, Feng-Chi Hsu, and Ghosh Tilottama. 2017. "VIIRS Night-Time Lights." *International Journal of Remote Sensing* 38 (June): 1–20. https://doi.org/10.1080/01431161.2017.1342050.