[*IS THERE REALLY A CAUSAL RELATIONSHIP BETWEEN NIGHT-TIME LIGHT INTENSITY AND ELECTRICITY CONSUMPTION ?*]

[Yongguang Zhu, China University of Geosciences, +8615337177886, zhuyongguang@cug.edu.cn]
[Deyi Xu, China University of Geosciences, +8618971639698, xdy@cug.edu.cn]
[Saleem Hassan Ali, University of Delaware, +13028310817, saleem@udel.edu]

Overview

In the field of Social Sciences, we often use second-hand data released by the government or research institutions. Statistical objects tend to be large scale administrative units, such as countries, provinces, etc. When studying smaller administrative units, data are often not available. Meanwhile, data are often not timeliness, and the time span is large. Croft (1978) discovered that nightlight data can be used as an indicator of human activities(Croft, 1978). Recently, scientists began to use remote sensing data to estimate the data of social activities. Among them, the night lighting data released by National Oceanic and Atmospheric Administration of the United States, NOAA, is the most used. The Data was collected by the Operational Linescan System (OLS) flown by the U.S.

Nightlight data is an important symbol of human activities, and it is also the most direct feature of the urbanization of human society in the spatial field. The multi-dimensional and multi-scale study of global and regional nightlight data is helpful to understand the coupling law between global environmental change and human environment(C. D. Elvidge et al., 1997). Because of their global extents, standardized production, and relative ease with which DMSP nighttime lights can be accessed, they have widely used as a proxy for other more difficult to measure these economic and social index(Lo, 2002). The logic is that urban processes are highly correlated with each other(Zhou et al., 2015). If one process or activity can be measured well, it can be used to make reasonable estimates of others. As examples, nighttime lights have been used to map energy production(Do et al., 2018; C. D. Elvidge et al., 2009), energy consumption (Letu, Hara, Yagi, Tana, & Nishio, 2009; Tripathy et al., 2018; Tyralis, Mamassis, & Photis, 2017), carbon emissions(Ghosh et al., 2010; Wang & Liu, 2017). In these papers, methods of estimation are linear regression, logic regression and power regression. Finally, these models can get a very high coefficient of determination or coefficient of correlation. Some of them can reach 99%. However, this is also the spurious regression signal in econometrics. So, we want to know whether there is a causal relationship between nightlight data and these social indexes, with the perspective of econometrics. In this paper, we select electricity consumption as research objects, and use econometric methods to test relationship between nighttime light data and electricity consumption in country level.

Methods

The analysis process is shown in the following figure. Non-causality for heterogeneous panel data models were used in this paper((Dumitrescu & Hurlin, 2012; Lopez & Weber, 2017).
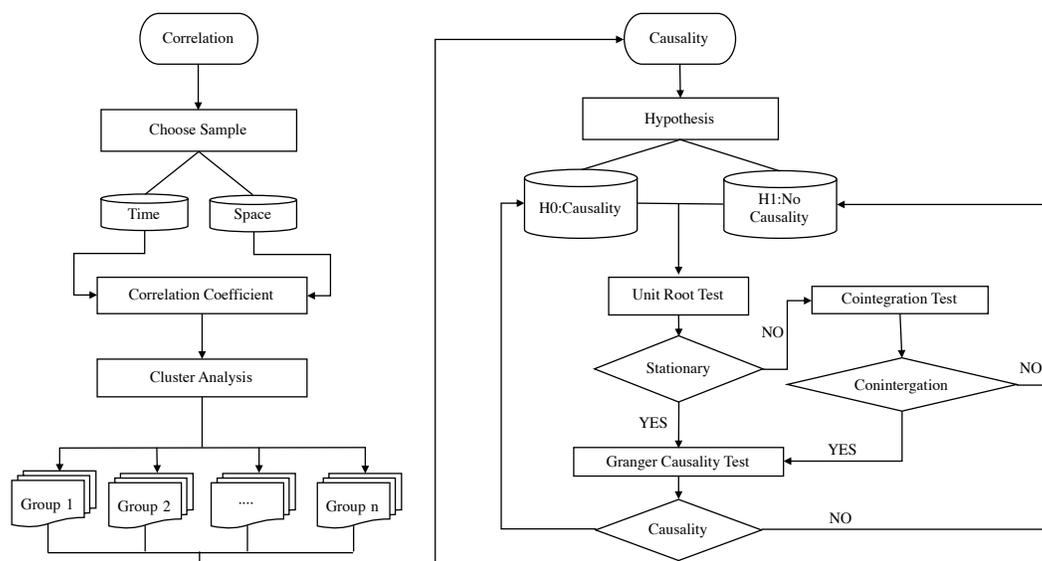

Figure 1 Analysis flow chart

Results

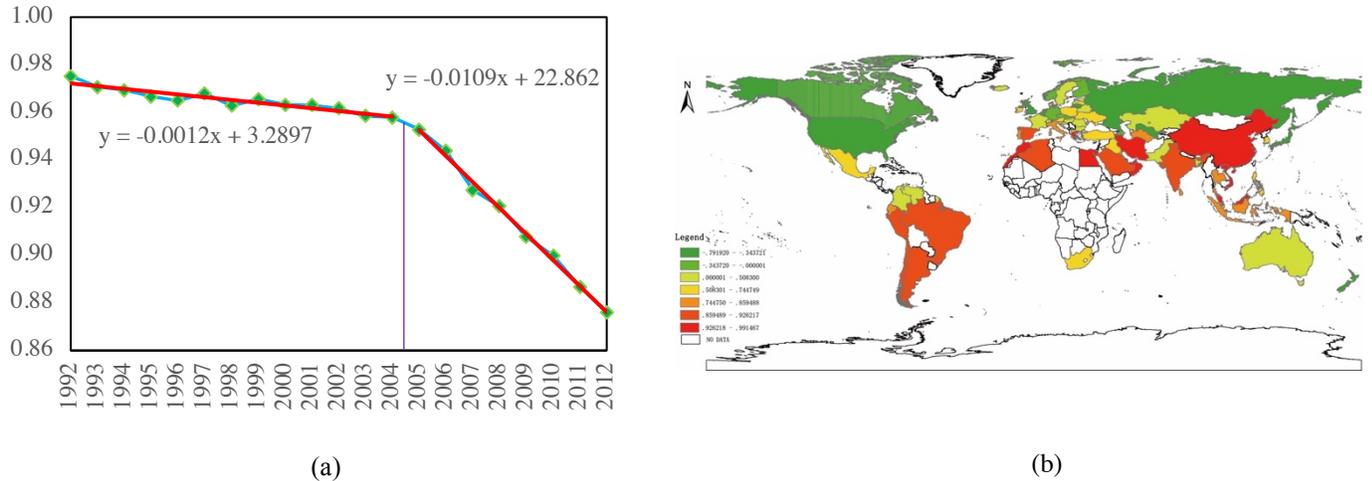Correlation analysis results are shown as follows:

(a)

(b)

Figure 2 Correlation Analysis

Causality analysis results are shown as follows:

Table 1 Causality Analysis

H0	Light does not homogeneously cause EC		EC does not homogeneously cause Light	
	number of lags	Z-bar Statistics	number of lags	Z-bar Statistics
All	-	-	-	-
Group 1	5	2.3734**	5	7.8490***
Group 2	5	0.5494	1	8.7235***
Group 3	-	-	-	-
Group 4	-	-	-	-
Group 5	5	7.9996***	5	12.1145***
Group 6	5	3.4454***	5	21.2654***
Group 7	5	1.1762	5	10.6500***

Conclusions

- The change of electricity consumption structure is the main reason for the decrease of the correlation between night light intensity and electricity consumption.
- Spatial heterogeneity exists in the relationship between night light intensity and electricity consumption.
- Night light intensity data are not suitable for estimating country level power consumption in spatial dimension.
- This method can be used to test other research objects, such as metal stocks, population, GDP, etc. Meanwhile, this method is also applicable when statistical data of smaller spatial units can be obtained, such as province level, city level, or smaller.

References

Shi, K. F., Yu, B. L., Huang, C., Wu, J. P., & Sun, X. F. (2018). Exploring spatiotemporal patterns of electric power consumption in countries along the Belt and Road. *Energy, 150*, 847-859. doi:10.1016/j.energy.2018.03.020.

Xie, Y. H., & Weng, Q. H. (2016). Detecting urban-scale dynamics of electricity consumption at Chinese cities using time-series DMSP-OLS (Defense Meteorological Satellite Program-Operational Linescan System) nighttime light imageries. *Energy, 100*, 177-189. doi:10.1016/j.energy.2016.01.058.