The Version of Record of this manuscript is available at *Time and Society* (2023) **32** doi:10.1177/0961463X221148804
Traducción al castellano disponible en https://hdl.handle.net/11441/142453

# Fatality risks in eccentric time localities: not that elevated

José María Martín-Olalla

*Universidad de Sevilla,*
*Facultad de Física,*
*Departamento de Física de la Materia Condensada,*
*ES41012 Sevilla,*
*Spain*[*]

(Dated: February 3rd, 2022)

```
File: mainAps.tex
Encoding: utf8
Words in text: 716
Words in headers: 10
Words outside text (captions, etc.): 181
Number of headers: 2
Number of floats/tables/figures: 3
Number of math inlines: 38
Number of math displayed: 0
```

Recently Gentry *et al.* (2022) analyzed the impact of the east-west gradient within a US time zone on the vehicle fatalities from 2006 to 2017. They distinguished control localities —those inside the physical time zone corresponding to their winter local time, referred as *solar*, as an example Houston, Texas— and the tested localities —those outside, west of, their physical time zone, referred as *Eccentric Time Locality (ETL)*, as an example Amarillo, Texas—. Their results were summarized on their Table 3, where population sizes $P$, accumulated fatalities $F$, and the fatality rates $R = F/P$ are listed for solar and ETL groups. Gentry *et al.* (2022) reported worse scores (larger fatalities) in the Easter, Central and Mountain ETL: $23.8\,\%, 17.7\,\%, 26.5\,\%$, respectively, comparing pairwise a solar location to their corresponding ETL.

All else equal, east-west gradient may impact societal issue like traffic accident rates. However the impact reported by Gentry *et al.* (2022) are staggering large. I offer an alternative explanation for their findings.

In their analysis, authors implicitly assume $F$ scales with $P$ through different geographical localities. However, when dealing with heterogeneous social magnitudes like $F$ one should be consider $F \propto P^{\alpha_e}$ where $\alpha_e$ is an empirical exponent, which may or may not be equal to one. I provide an analogy based on mortality. I got weekly numbers of deaths in Spain since 2000 disaggregated by NUTS3 regions[1] ($N = 52$). I tested the logarithmic of the accumulated values against the logarithm of the average population in every region. I found $\alpha_e = 0.92$ with 95 % confidence interval (CI) $[0.86, 0.98]$. In this case $\alpha_e \neq 1$ is related to the myriad of societal issues that impact mortality of which differences in the age distribution along the Spanish NUTS2 regions are probably the most significant: with rural regions less populated and aged the distribution flattens and the effective exponent decreases.[2]

In the case of the vehicle fatalities analyzed by Gentry *et al.* (2022) the authors list a series of factor that also lead to road accidents in Section *Limitations*. In other words, in addition to the east-west gradient, $F$ must depend on other environmental conditions such as, but not limited to: population density, population age, miles traveled, road conditions, emergency responses, weather conditions. All these factors jeopardize a simple $F \propto P$ coupling.

I show in Figure 1 a double logarithm plot of the fatalities versus population sizes. Visually speaking, ETL observations are not outliers in this chart.

I performed several $F = a \times P^{\alpha_e}$ tests, where $a$ is an effective rate of fatalities. The tests involved: (1) the set of seven observations; (2) the set of four solar observations; (3) the set of three ETL observations. Results are summarized on table I. In figure 1 I show the fitting results for the seven observations (orange line) and the four solar observations (blue line). I find point estimates $\alpha_e \neq 1$, with the 95 %CI including $\alpha_e = 1$. In reverse this usually means that the null hypothesis "$F/P$ does not depend on $P$" sustains at the standard level of confidence in every analysis. This is due to the scarcity of observations and their strong variability. Worse, the 95 %CI for the rates

* olalla@us.es; https://orcid.org/0000-0002-3750-9113; https://ror.org/03yxnpp24;

[1] Nomenclature of Territorial Units for Statistics, https://ec.europa.eu/eurostat/web/nuts/background

[2] The impact of age/sex population structure is remove by using age-specific death rates or the life expectancy at birth.

Typeset by REVTEX

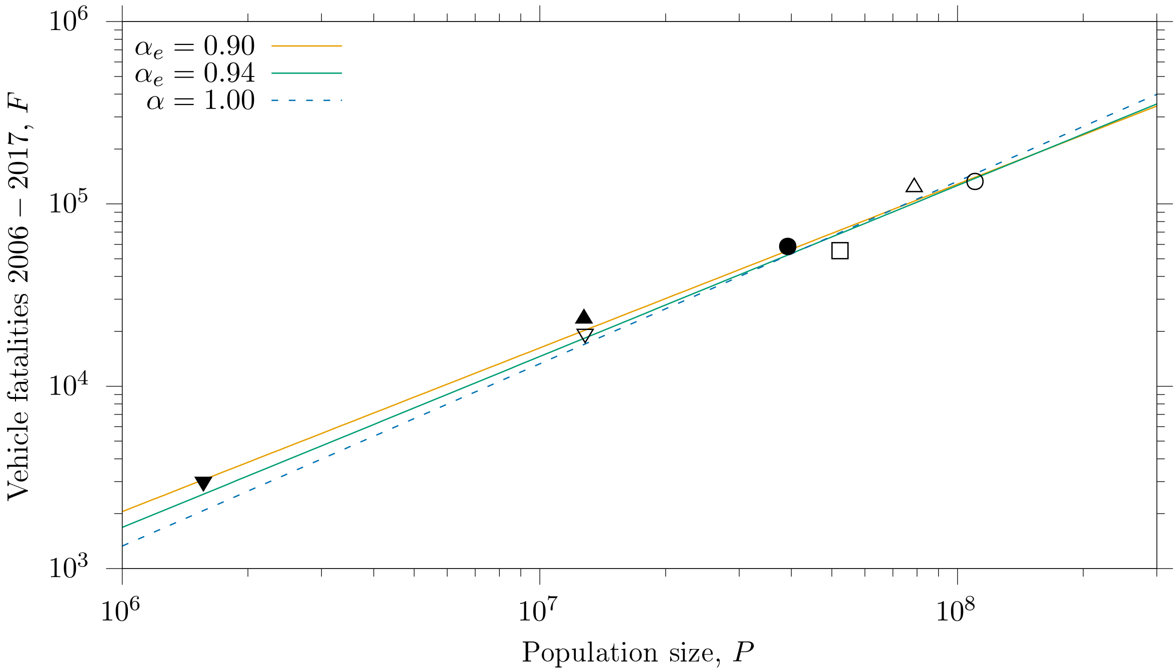


FIG. 1 Double logarithmic plot of the fatalities to population relationship in Gentry *et al.* (2022). The solid symbols denote ETL observations; the open symbols solar observations. Circles: Eastern Time Zone; up triangles: Central Time Zone; down triangles: Mountain Time Zone: square: Pacific Time Zone. The solid orange line shows the fitting for the solar observations and the solid blueish line, the fitting for the total observations; see Table I. For the purpose of comparison I show $\alpha = 1$ as a broken line.

$a$ are extremely wide.

Finally Table II mimics the results presented by Gentry *et al.* (2022) in their Table 3. I include two more data columns aiming to simulate the effect of the scaling relation: $F/P^{\alpha_e^{\mathrm{solar}}}$ and $F/P^{\alpha_e}$, where from Table I $\alpha_e^{\mathrm{solar}}$ is the effective exponent for the solar analysis, and $\alpha_e$ is the effective exponent for the complete analysis.

I also computed the percent worsening deduced from the ratio of ETL rates to solar rates. I do not claim this is a good measure of the impact of west-east gradient on fatalities but it mimics Gentry *et al.* (2022) argument and it helps to visualize the strong dependence of this metric on $\alpha_e$.

More observations would be needed to assess a precise value for $\alpha_e$ in the United States. Disaggregated numbers by county may provide some insight on this relation. Very likely the impact of the eccentric time zones is not an increase of 20 % in vehicles fatalities as Gentry *et al.* (2022) claimed.

## TIME LINE

On November 5th 2022, the social network `ResearchGate` recommended JMM-O a manuscript by Winnebeck (2022), from which JMM-O knew about the targeted manuscript by Gentry *et al.* (2022). On November 9th 2022, JMMO submitted this original version to *Time and Society*. It was accepted for publication on December 14th, 2022 and released online on February 3rd, 2023.

## REFERENCES


Gentry, Jeffery, Jayson Evaniuck, Thanchira Suriyamongkol, and Ivana Mali (2022), "Living in the wrong time zone: Elevated risk of traffic fatalities in eccentric time localities," Time and Society **31**, 457–479.

Winnebeck, Eva C (2022), "Chronobiology: Is daylight saving time a deer saving time?" Current Biology **32**, PR1283–PR1286.

| **Set** | $N$ | $\alpha_e$ | 95 %CI | $a$ | 95 %CI | $p-$value |
|---|---|---|---|---|---|---|
| All observations | 7 | 0.90 | $[0.78, 1.02]$ | $8.43 \times 10^{-3}$ | $[1.09 \times 10^{-3}, 6.49 \times 10^{-2}]$ | $< 0.001$ |
| Solar observations | 4 | 0.94 | $[0.36, 1.51]$ | $3.99 \times 10^{-3}$ | $[1.51 \times 10^{-7}, 1.05 \times 10^{2}]$ | 0.02 |
| ETL observations | 3 | 0.93 | $[0.31, 1.56]$ | $4.94 \times 10^{-3}$ | $[2.14 \times 10^{-7}, 1.14 \times 10^{2}]$ | 0.03 |

TABLE I Results from the fit $F = a \times P^{\alpha_e}$ for set of data. Figure 1 shows the fittings for the solar and total observations. The effective exponent drives the slope in the double-logarithm plot; the effective rate $a$ drives the intercept value at $P = 1$.

| **Time Zone** | **Class** | Fatalities $F$ | Population $P$ | $F/P^1$ $\times 1000$ | **Pct worse** | $F/P^{\alpha_e^{\text{solar}}}$ $\times 1000$ | **Pct worse** | $F/P^{\alpha_e}$ $\times 1000$ | **Pct worse** |
|---|---|---|---|---|---|---|---|---|---|
| Eastern | Solar | 132 722 | 110 133 372 | 1.205 | | 3.833 | | 7.992 | |
| | ETL | 58 478 | 39 199 427 | 1.492 | 23.8 | 4.448 | 16.1 | 8.903 | 11.4 |
| Central | Solar | 124 890 | 78 783 002 | 1.585 | | 4.938 | | 10.159 | |
| | ETL | 23 789 | 12 746 474 | 1.866 | 17.7 | 5.188 | 5.1 | 9.930 | −2.3 |
| Mountain | Solar | 19 180 | 12 834 599 | 1.494 | | 4.156 | | 7.957 | |
| | ETL | 2959 | 1 564 684 | 1.891 | 26.5 | 4.611 | 11.0 | 8.121 | 2.1 |
| Pacific | Solar | 55 381 | 52 317 788 | 1.059 | | 3.214 | | 6.506 | |
| Total | Solar | 332 173 | 254 068 761 | 1.307 | | 4.381 | | 9.444 | |
| | ETL | 85 226 | 53 510 585 | 1.593 | 21.8 | 4.842 | 10.5 | 9.812 | 3.9 |
| Total | Total | 417 399 | 307 579 346 | 1.357 | | 4.602 | | 9.995 | |

TABLE II Main results from Table 3 in Gentry *et al.* (2022) augmented with the $F/P^{\alpha_e^{\text{solar}}}$ and $F/P^{\alpha_e}$ columns. From left to right the changes in the percentage worse of the ETL observations on $\alpha_e$ can be appreciated. Point estimate values of the effective exponents were $\alpha_e^{\text{solar}} = 0.937\,512$ and $\alpha_e = 0.897\,831$. See table I for their 95 %CI.