

# Choosing an appropriate scalar transformation to normalise wpd

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- Data presented

Observations are generated from a  $N(0,1)$  distribution for each combination of  $nx$  and  $nfacet$  from the following sets:  $nx = nfacet = \{2, 3, 5, 7, 14, 20, 31, 50\}$  to cover a wide range of levels from very low to moderately high. Each combination is being referred to as a *panel*. That is, data is being generated for each of the panels  $\{nx = 2, nfacet = 2\}, \{nx = 2, nfacet = 3\}, \{nx = 2, nfacet = 5\}, \dots, \{nx = 50, nfacet = 31\}, \{nx = 50, nfacet = 50\}$ . For each of the 64 panels,  $ntimes = 500$  observations are drawn for each combination of the categories. That is, if we consider the panel  $\{nx = 2, nfacet = 2\}$ , 500 observations are generated for each of the combination of categories from the panel, namely,  $\{(1, 1), (1, 2), (2, 1), (2, 2)\}$ . The values of  $\lambda$  is set to 0.67 and values of raw wpd is obtained.

- How the distribution of the raw wpd (without any transformation for normalization) looks across nfacets and nx? Both shape and scale of the distribution changes for different nx and nfacet categories as could be seen in Figure ??.
- Plot the values of raw wpd against  $nx*nfacet$  to see the rough relationship (??).

## Current attempt

- Fit a log-linear model of median(values) to  $\log(nx*nfacet)$  as discussed today. The fit is pretty good and the summary of the fit is shown below.

```
N01_median <- N01 %>%
  group_by(nx*nfacet) %>%
  summarise(actual = median(value))

fit_lm2 <- lm(actual ~ poly(log(`nx * nfacet`), 1, raw=TRUE), data = N01_median)
summary(fit_lm2)
```

```
##
## Call:
## lm(formula = actual ~ poly(log(`nx * nfacet`), 1, raw = TRUE),
##     data = N01_median)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.0021910 -0.0002941  0.0001063  0.0003966  0.0009917
##
## Coefficients:
```

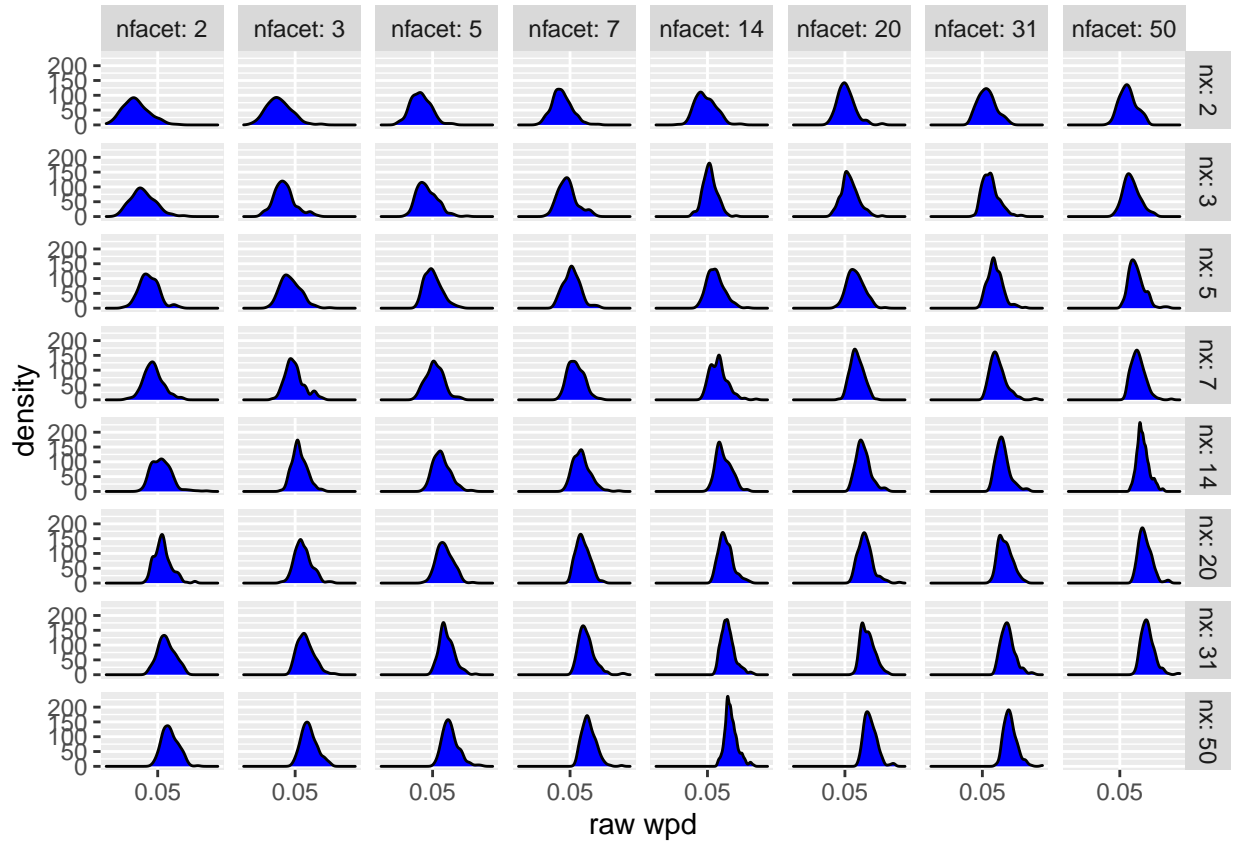


Figure 1: Distribution of raw wpd is plotted across different nx and nfacet categories. Both shape and scale of the distribution changes for different nx and nfacet categories.

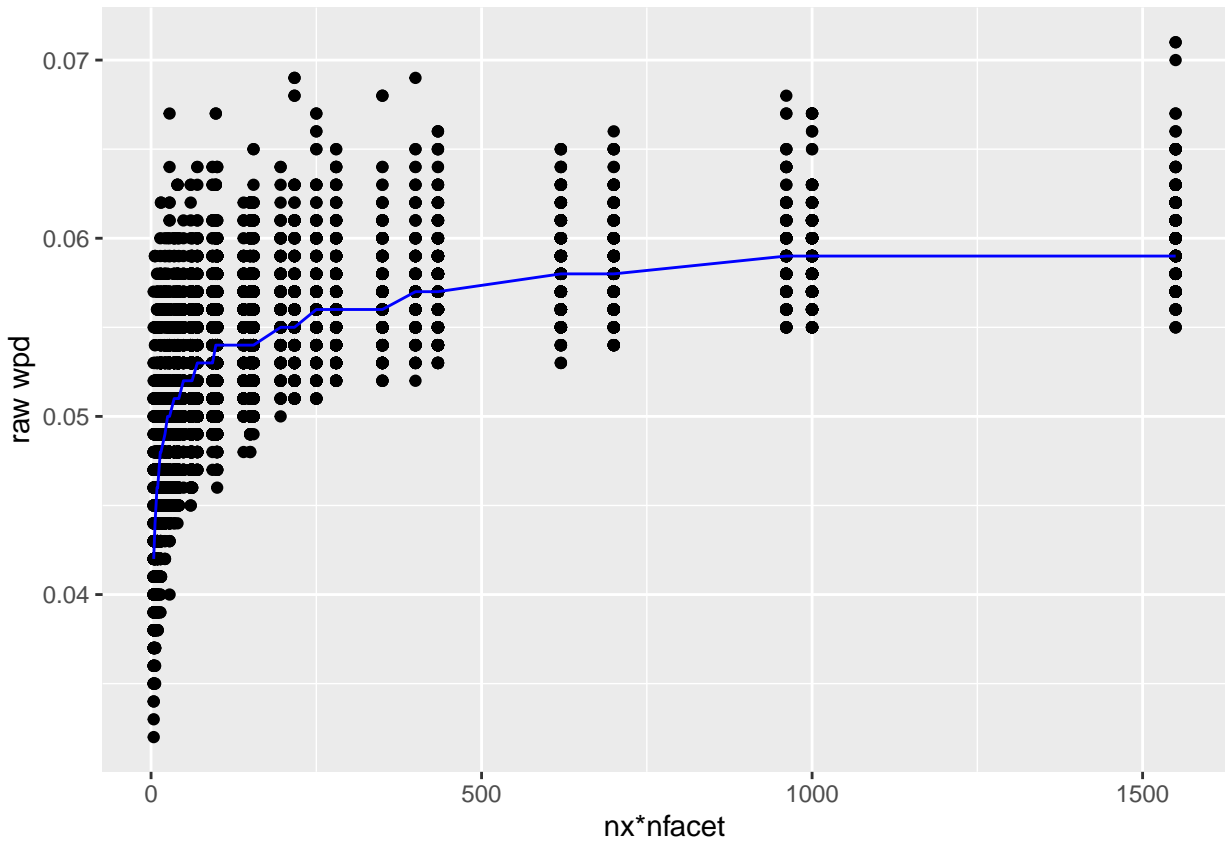
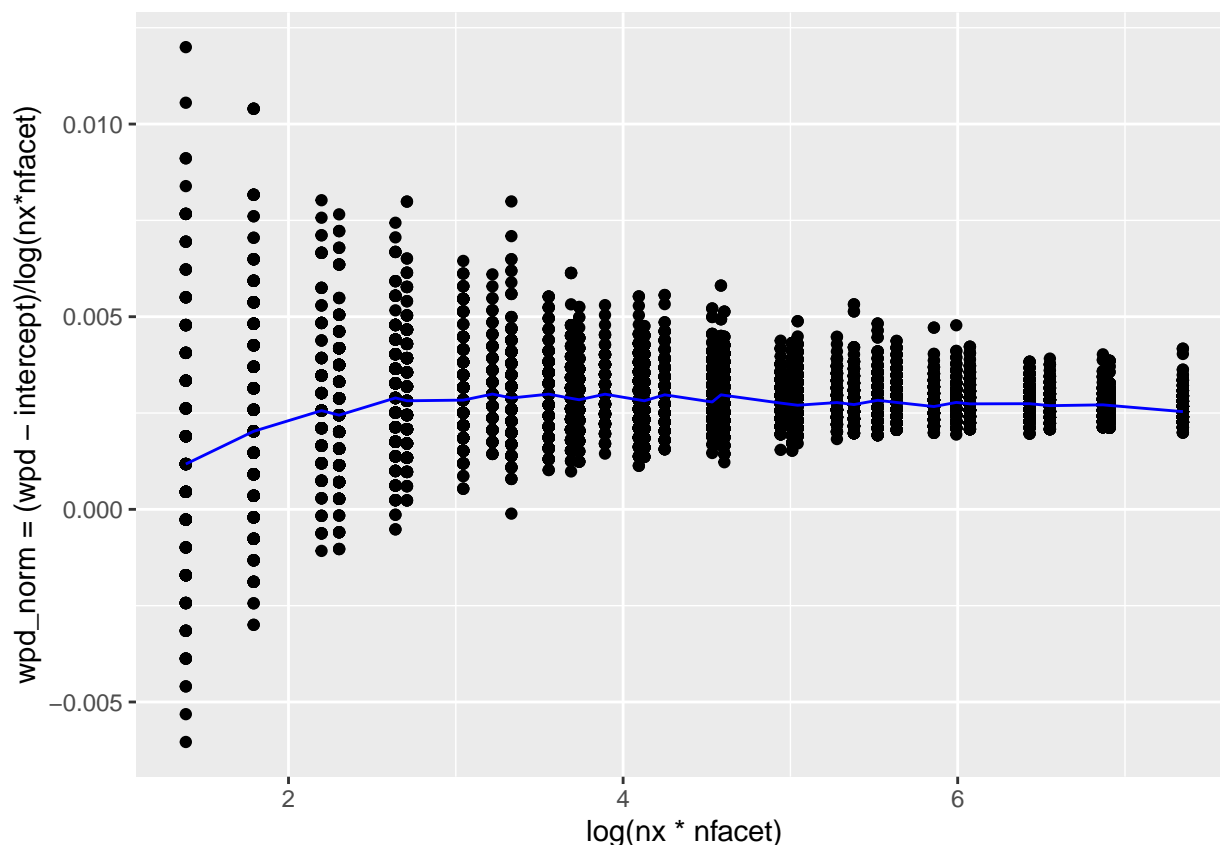


Figure 2: The raw wpd is plotted against  $nx \cdot nfacet$  and the blue line represents the median of the multiple values for each  $nx \cdot nfacet$  levels.

```
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    4.037e-02  3.814e-04  105.85   <2e-16
## poly(log(`nx * nfacet`), 1, raw = TRUE) 2.757e-03  8.043e-05   34.27   <2e-16
##
## (Intercept)                    ***
## poly(log(`nx * nfacet`), 1, raw = TRUE) ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0007206 on 32 degrees of freedom
## Multiple R-squared:  0.9735, Adjusted R-squared:  0.9727
## F-statistic: 1175 on 1 and 32 DF,  p-value: < 2.2e-16
```

- Make it a horizontal line so that the values are not affected by  $nx \cdot nfacet$  by plotting  $wpd_{norm} = (value - intercept)/\log(nx \cdot nfacet)$  against  $\log(nx \cdot nfacet)$ . The line actually becomes horizontal after this transformation as could be seen in Figure ??.



See distribution of the transformed variable  $wpd_{norm}$  across  $nx$  and  $nfacet$ . For higher values of  $nx$  and  $nfacet$ , the distribution is similar, but not for lower values.

It was suggested that we can do permutation normalization for smaller levels and this scalar transformation for higher levels as this transformation is working well when both  $nx$  and  $nfacet$  are high enough. There are potentially two problems if we follow that approach:

- Since the normalized  $wpd$ 's for different harmonies will be on different scales, harmonies could not be ranked even for the same objects (households) to select the most important household for that object - which was essentially the idea. Hence, the normalized  $wpd$ 's would have to be brought on the same scale irrespective of the approach (whether permutation approach or scalar transformation).

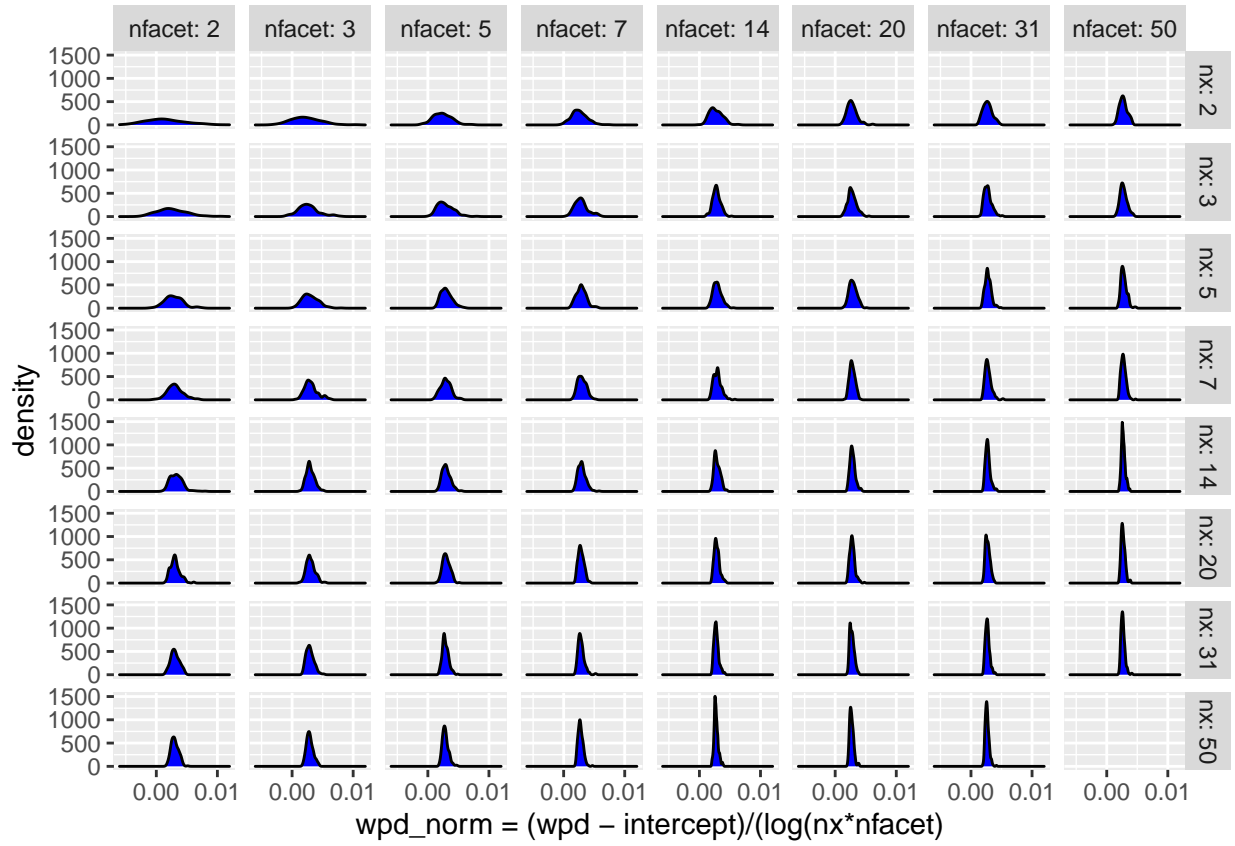


Figure 3: The distribution of the transformed  $wpd$  is plotted. The shape and the scale of the distribution still changes across different  $nx$  and  $nfacet$  levels, but seems uniform for higher levels.

- We have to think about the cut-offs, that is, for which level of  $n_x$  and  $n_{\text{facets}}$ , we want to move to scalar transformation like this.