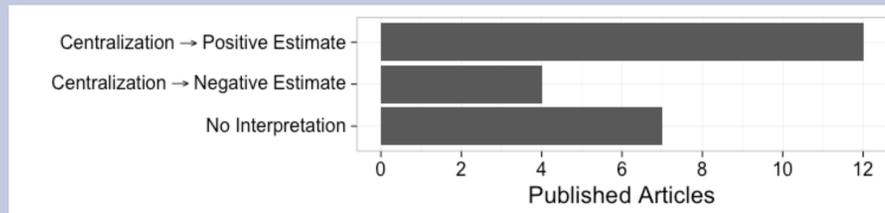


# Interpretation of GW-Degree Estimates in ERGMs

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## The literature is ambiguous about how to interpret GW-Degree estimates

- Geometrically weighted (GW) parameters:
  - Help avoid model degeneracy
  - Model important network properties:
    - Centralization (GW-Degree, GWD)
    - Triadic closure (GW-Edgewise shared partners, GWESP)
- Interpretations of GWD estimates vary

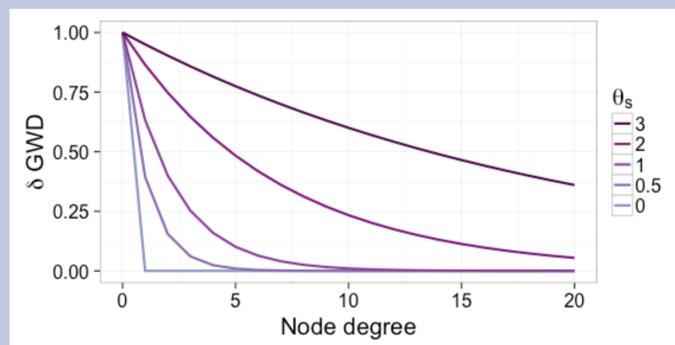


Interpretation of empirical GWD estimates in refereed articles.

**Literature reviewed:** Angst and Hirschi (2016), Box-Steffensmeier and Christenson (2015), Brownson et al. (2010), Gallemore et al. (2015), Goodreau (2007), Harris et al. (2012), Helfstein and Wright (2011), Huang, Shen, and Contractor (2013), Huang et al. (2009), Jasny (2012), Jin, Yuan, and Liang (2013), Labeyrie et al. (2016), Luke et al. (2013), Luke et al. (2010), Lungeanu, Huang, and Contractor (2014), Papachristos, Hureau, and Braga (2013), Parra et al. (2011), Potter and Hancock (2010), Saul and Filkov (2007), Schaefer et al. (2011), Scott and Thomas (2015), Toivonen et al. (2009), Wimmer and Lewis (2010)

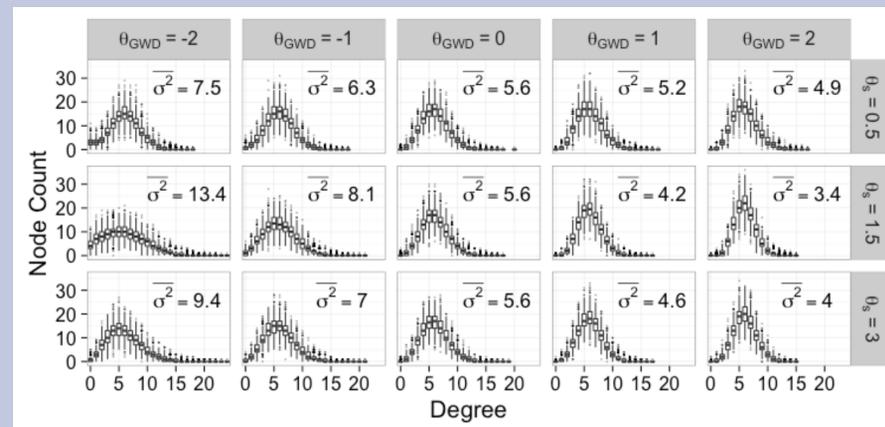
## The GWD statistic increases more for edges added to lower-degree nodes

- Adding any edge increases GWD
- Edges on low-degree nodes increase GWD more
- Smaller  $\theta_s$  values put more action on low-degree nodes



Change to GWD statistic for adding a (half) edge as a function of the degree of the receiving node and the decay parameter,  $\theta_s$ .

## Negative GWD coefficients yield centralized networks



Degree distributions of 1000 simulated networks with 100 nodes and mean degree 2.5, for each combination of  $\theta_{GWD}$  and  $\theta_s$ . Average variance of the degree distribution is reported.

## Conclusions & Suggestions

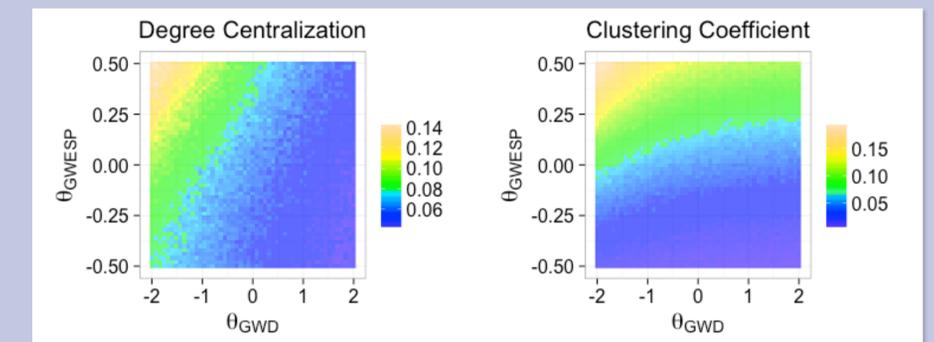
- $\theta_{GWD} < 0$  indicates centralization of edges
- $\theta_{GWD} > 0$  indicates dispersion of edges
- GWD always responds more to changes to low-degree nodes
- As  $\theta_s$  increases, GWD responds more to changes to higher-degree nodes
- $\theta_s$  should always be positive (not shown; see “Statistic Behavior” tab in Shiny app, below)
- The appropriate value of  $\theta_s$  depends on network size and density in addition to the effect being modeled. The Shiny app associated with this poster is meant to help with this selection process.
- At least by default,  $\theta_{GWESP}$  should be included with  $\theta_{GWD}$  to avoid confounding centralization and clustering.

Scan the QR code or visit [michaellevy.shinyapps.io/gwdegree](http://michaellevy.shinyapps.io/gwdegree) for interactive versions of these visualizations that allow custom network size, densities, and parameter values.



## Centralization (GWD) & clustering (GWESP) are confounded ...

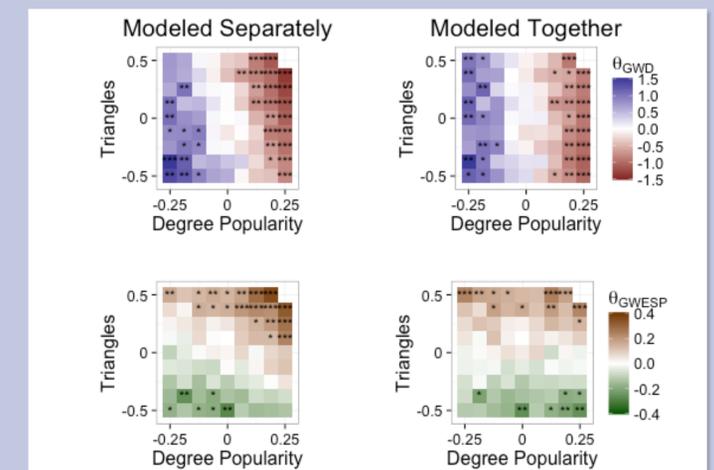
- Concentrating edges leads to complete triangles, without a per se triadic closure force; likewise, a tendency to form triangles concentrates edges



Each grid point is mean centralization or clustering of 25 100-node, mean-degree-2.5 networks. Fixed decays:  $\theta_s = 1.5$  and  $\theta_\tau = 0.5$ .

## ... But ERGMs can distinguish them

- Modeled together, GWESP recovers triangles and GWD recovers degree popularity



Eight 100-node, mean-degree-2.5 networks were simulated with each combination of triangle and degree-popularity parameter values. On each network three ERGMs were estimated with an edges term and: only GWD (top-left), only GWESP (lower-left), or both (right);  $\theta_s = 1.5$ ,  $\theta_\tau = 0.5$ . Colors are median estimates across the eight networks; stars are median p-values (\*\*\*)  $p < 0.01$ , (\*\*)  $p < 0.05$ , (\*)  $p < 0.1$ .