

Abundance-driven vs. observed change

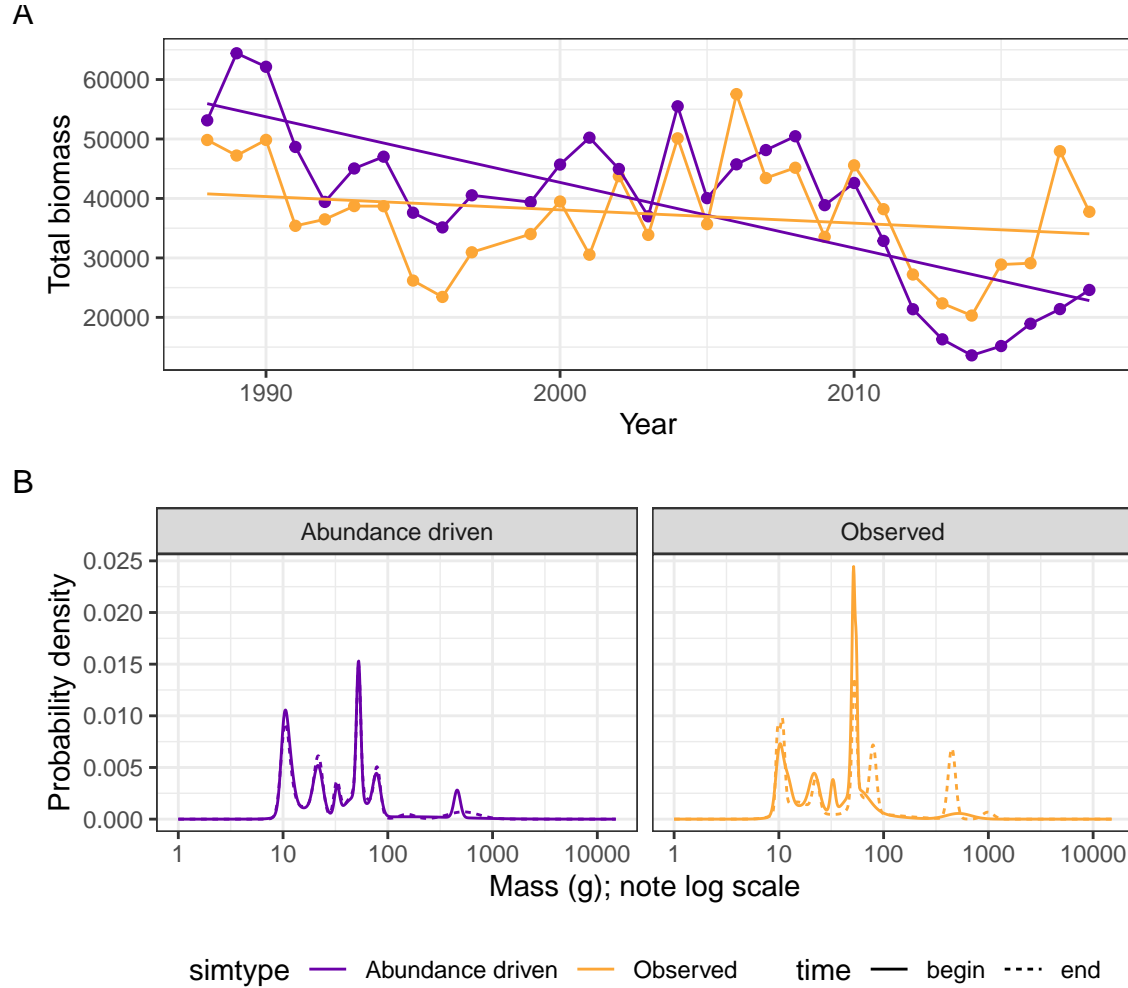


Figure 1. Illustration of abundance-driven (null model) dynamics as compared to observed dynamics (A), and the underlying dynamics of the ISD (B) for a sample route (LINDBROOK, Alberta). **A. Dynamics of total biomass.** The orange points show the true values for total biomass in each year, and the purple points show the values for total biomass simulated from a null model that incorporates change in total abundance, but assumes no change in the size structure, over time. The smooth lines show the predicted values from an ordinary (Gaussian) linear model of the form $\text{total_biomass} \sim \text{year} * \text{simtype}$. The solid and dotted rectangles show the segments of the timeseries used to construct the “beginning” and “ending” ISDs shown in panel B, respectively. For this route, change in the individual size distribution has decoupled the dynamics of biomass from those that would occur due only to changes in abundance. The slope for abundance-driven dynamics is significantly more negative than for the observed dynamics (interaction term $p = 0.0015$), which do not have a slope significantly different from zero (slope term $p = .23$). **B. Underlying changes in the ISD.** The individual size distributions for the first 5 years (solid lines) and last 5 years (dashed lines) of the timeseries. The x-axis is body size (as mass in grams; note log scale) and the y-axis is probability density from a Gaussian mixture model fit to a vector of simulated individual masses for all individuals observed in the years in questions, standardized to sum to 1. For the abundance-driven (purple) scenario, individuals’ species identities (which determine their body size estimates) are re-assigned at random weight by each species’ mean relative abundance throughout the timeseries, resulting in a consistent individual size distribution over time. For the observed (orange) scenario, individuals’ body sizes are estimated based on their actual species identities. For this route, species composition has shifted over time, resulting in distinct

ISDs for the “begin” and “end” time periods. Specifically, the “end” ISD has peaks at larger body sizes (ca. 90g and 500g) not present in the “begin” ISD. This redistribution of density towards larger body sizes results in an overall increase in body size community wise, which partially offsets declines in total biomass from those expected given change in abundance alone.

Biomass

Model outcomes

Overall proportion of routes with winning models:

model_family	model_formula	n	prop
Gamma	1	239	0.3234100
Gamma	timeperiod	351	0.4749662
Gamma	timeperiod * source	149	0.2016238

Of models with slope term, the proportion for which abundance and biomass are increasing:

abundance_increasing	n	prop
FALSE	335	0.67
TRUE	165	0.33

biomass_increasing	n	prop
FALSE	256	0.512
TRUE	244	0.488

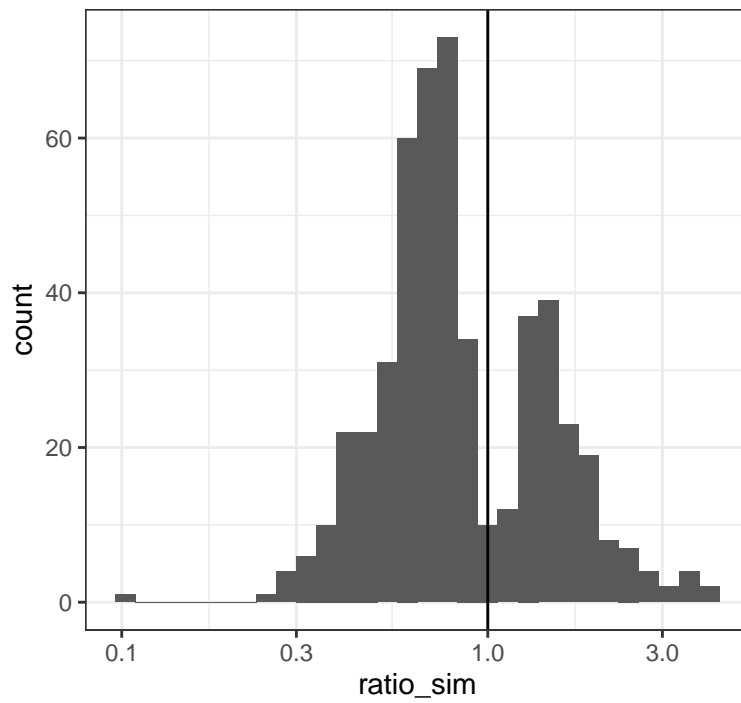
Restricted to models with an *interaction*:

abundance_increasing	n	prop
FALSE	120	0.8053691
TRUE	29	0.1946309

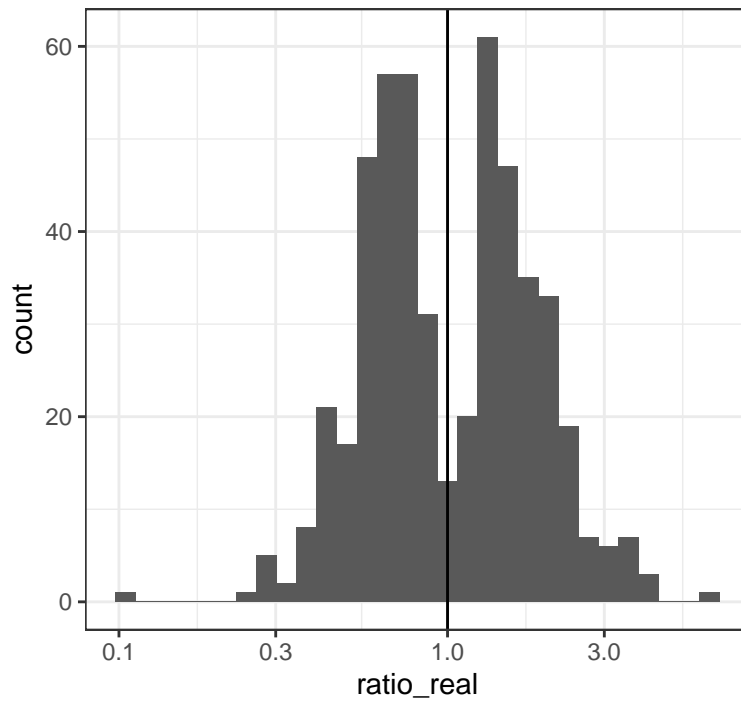
biomass_increasing	n	prop
FALSE	41	0.2751678
TRUE	108	0.7248322

Direction and magnitude of slopes

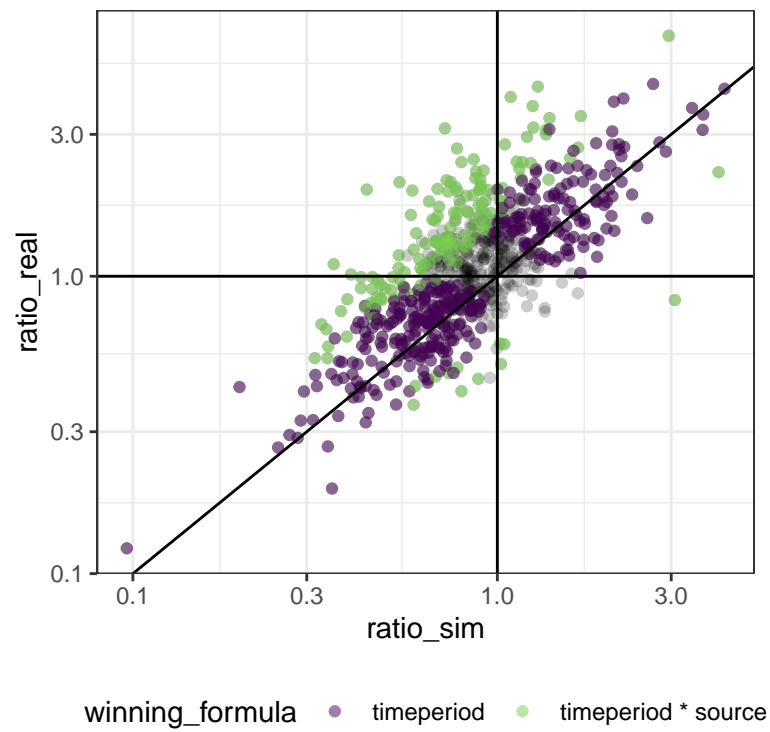
Abundance-driven (null model) slope



Observed slope



Direction of decoupling



Energy use

Model outcomes

Overall proportion of routes with winning models:

model_family	model_formula	n	prop
Gamma	1	230	0.3112314
Gamma	timeperiod	456	0.6170501
Gamma	timeperiod * source	53	0.0717185

Of models with slope term, the proportion for which abundance and biomass are increasing:

abundance_increasing	n	prop
FALSE	355	0.697446
TRUE	154	0.302554

energy_increasing	n	prop
FALSE	329	0.6463654
TRUE	180	0.3536346

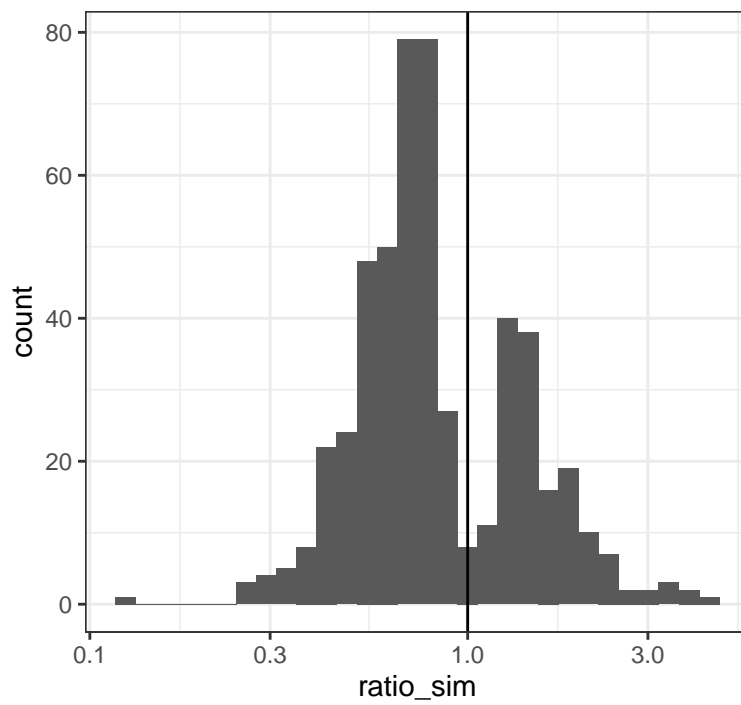
Restricted to models with an *interaction*:

abundance_increasing	n	prop
FALSE	42	0.7924528
TRUE	11	0.2075472

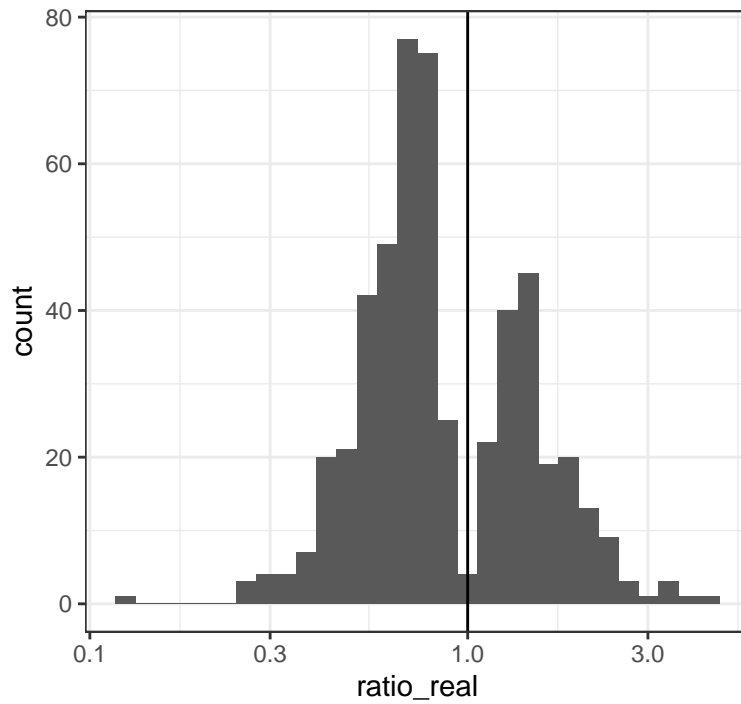
energy_increasing	n	prop
FALSE	16	0.3018868
TRUE	37	0.6981132

Direction and magnitude of slopes

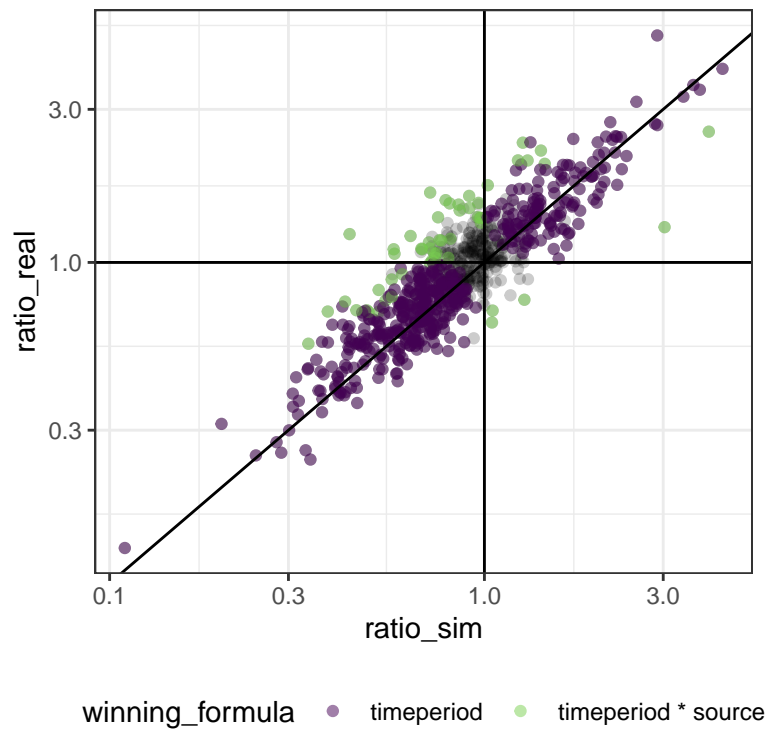
Abundance-driven (null model) slope



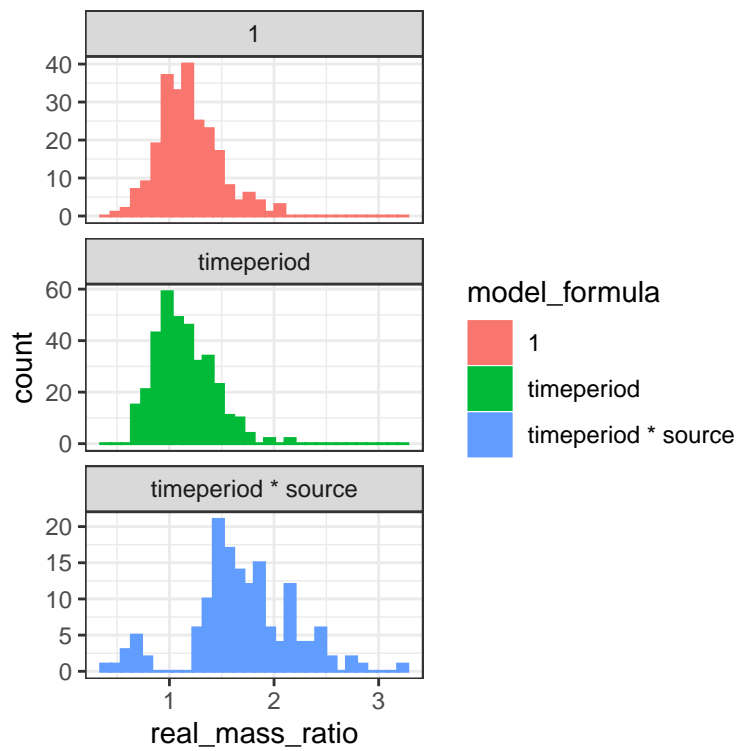
Observed slope



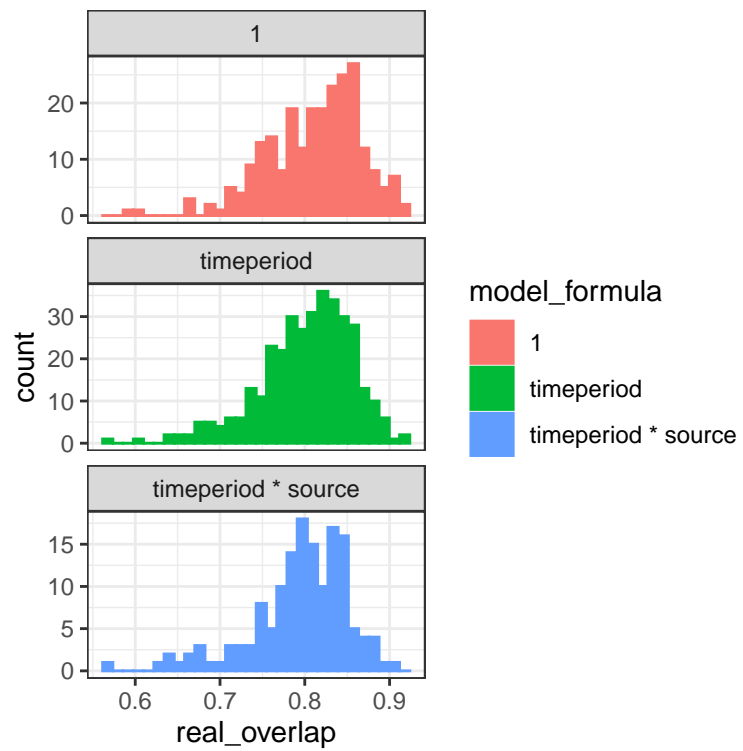
Direction of decoupling



Change in mean body size



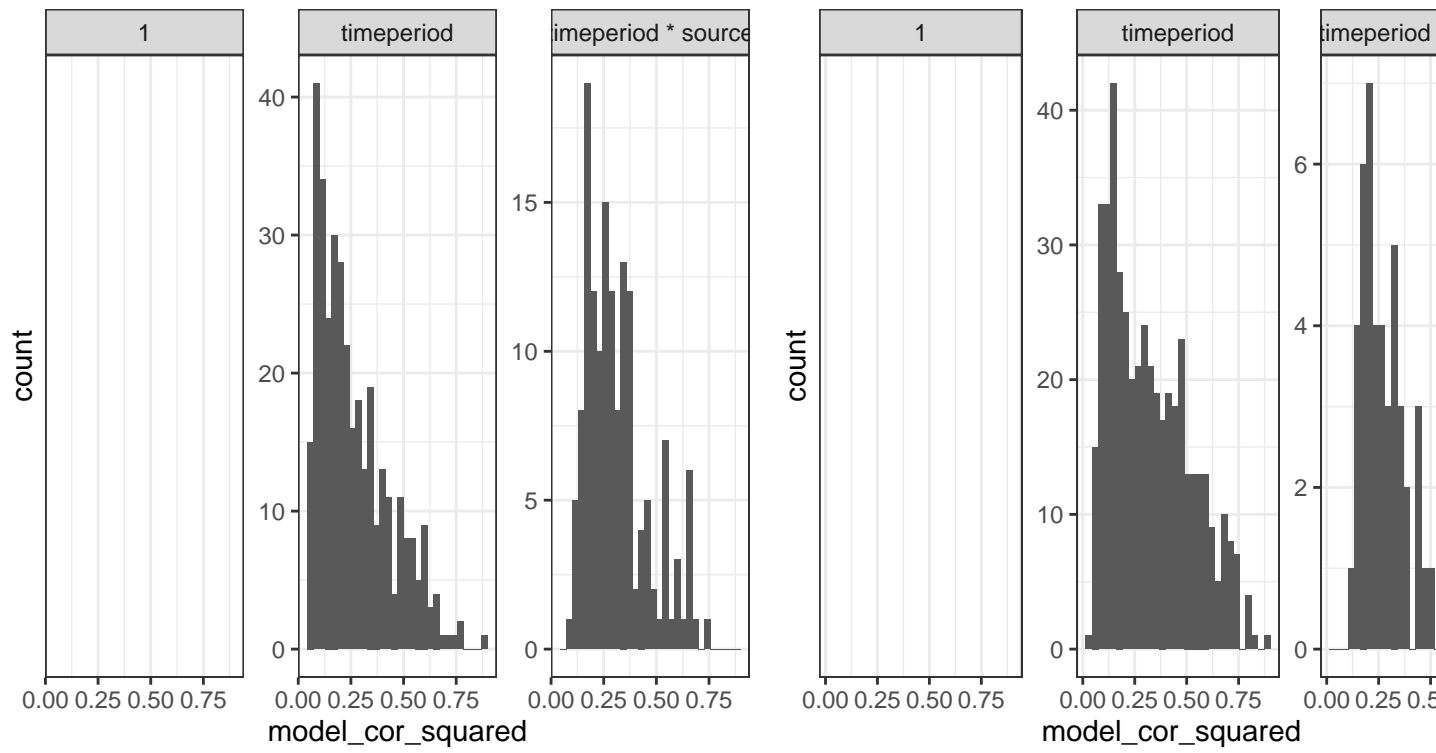
ISD overlap



R2 of binomial GLM $\text{overlap} \sim \text{model_formula}$ (which does not beat a $\text{overlap} \sim 1$ via AIC, FYI)

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## [1] 0.01288145
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Goodness of fit of models



References