ENSO increases foreign fishing

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Abstract

Illegal, unreported and unregulated (IUU) fishing contributes to x% of the global fishing ecconomy. Foreign fishing in a nation's Exclusive Economic Zone (EEZ) contributes to a y% of IUU fishing [Cabral et al., 2018]. Drivers of foreign fishing include a, b and c, but it is unclear how this may change under climate change. We show ENSO events increase foreign fishing by z%. This effect is larger for vessels with less fishing experience and lower for vessels with higher fishing experience. We also find the effect is lower for more adaptive gears such as longliners. This quantitative evidence linking climate and fishing behavior have important implications for climate projections and adaptation of this sector

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To do list

- Revise methods and explain how SST - nino 3 teleconnection was calculated
- Describe each dataset
- Build a brief introduction
- Update the specifications

Introduction

Methods

Data

GFW data

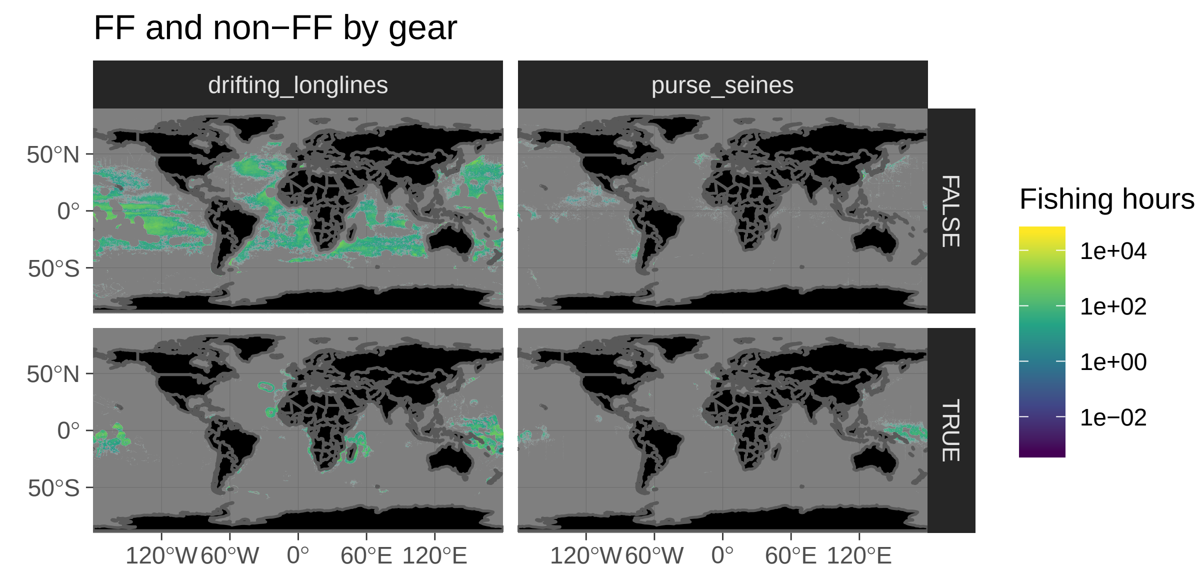

Figure 1: Fishing effort (hours) by gear and foreign fishing

ENSO data

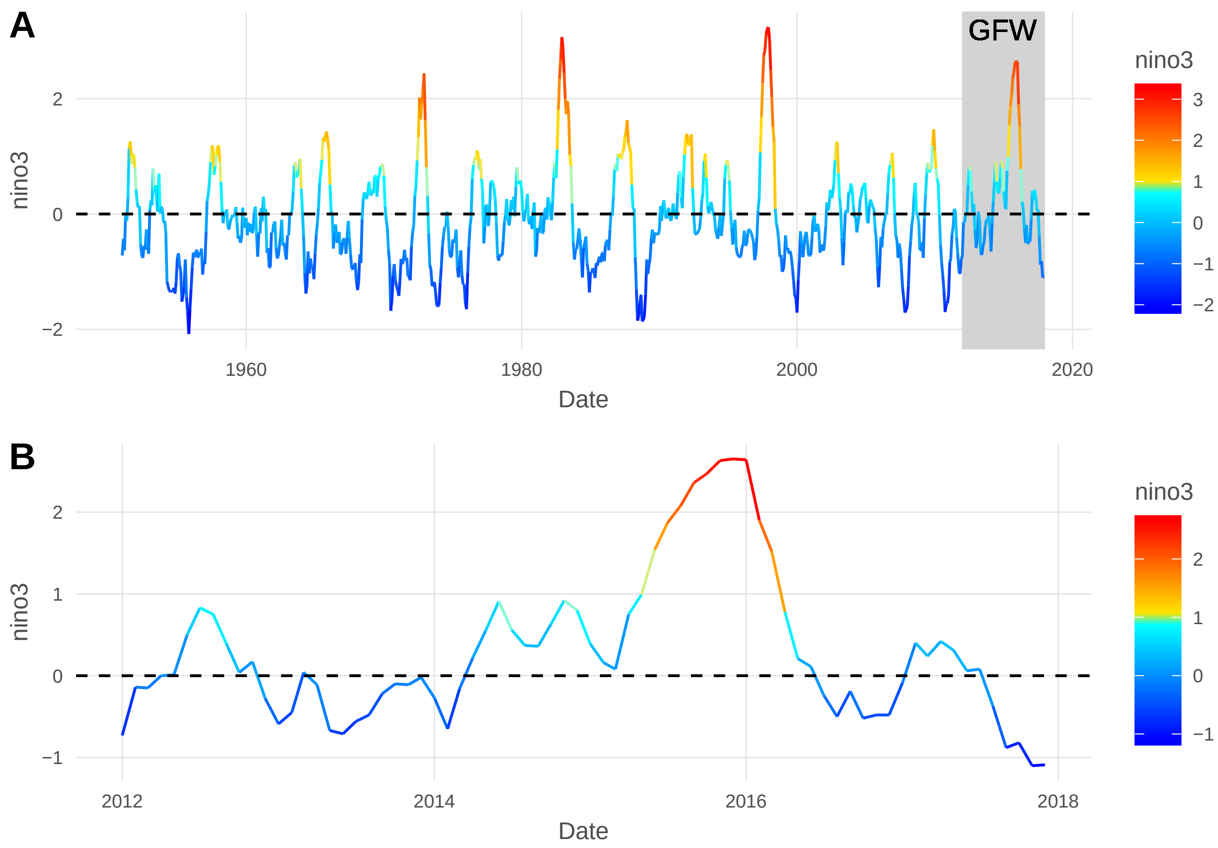

Figure 2: Timeseries of nino3 index (detrended) for A) The entire length and B) timespan matching GFW data

SST Data

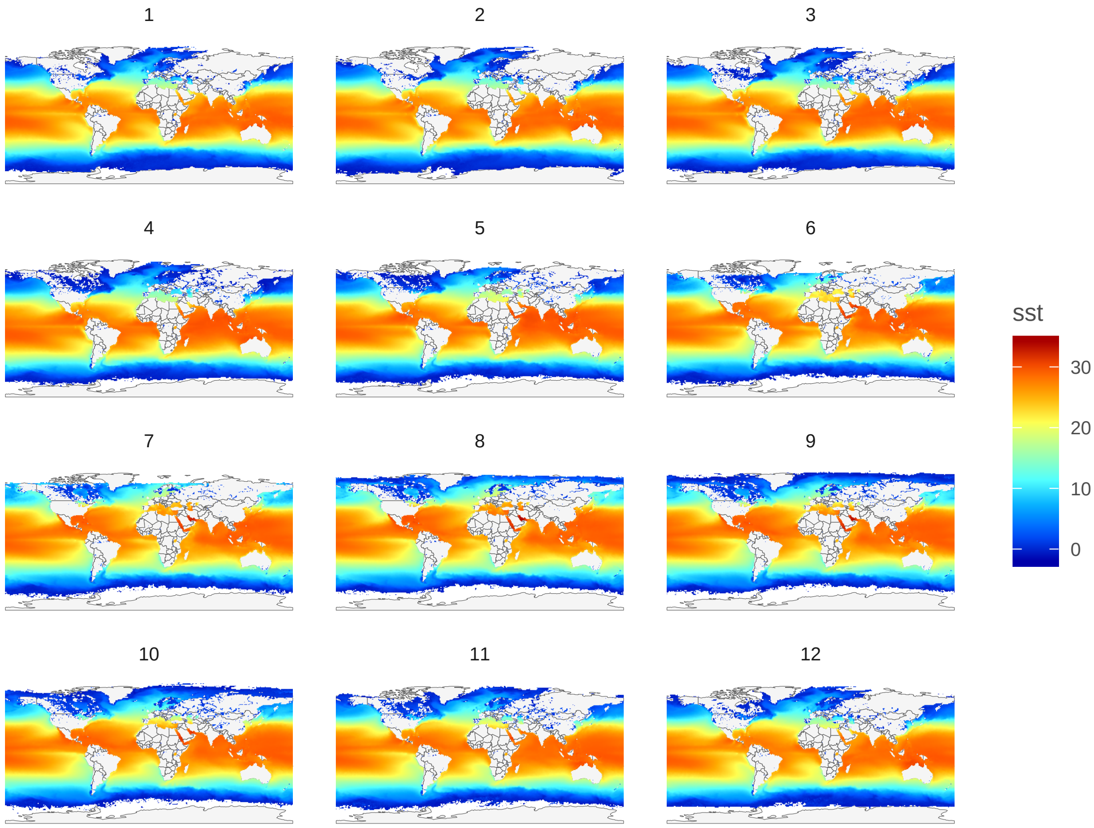

Figure 3: Mean monthly SST

Empirical specifications

ENSO and Foreign Fishing

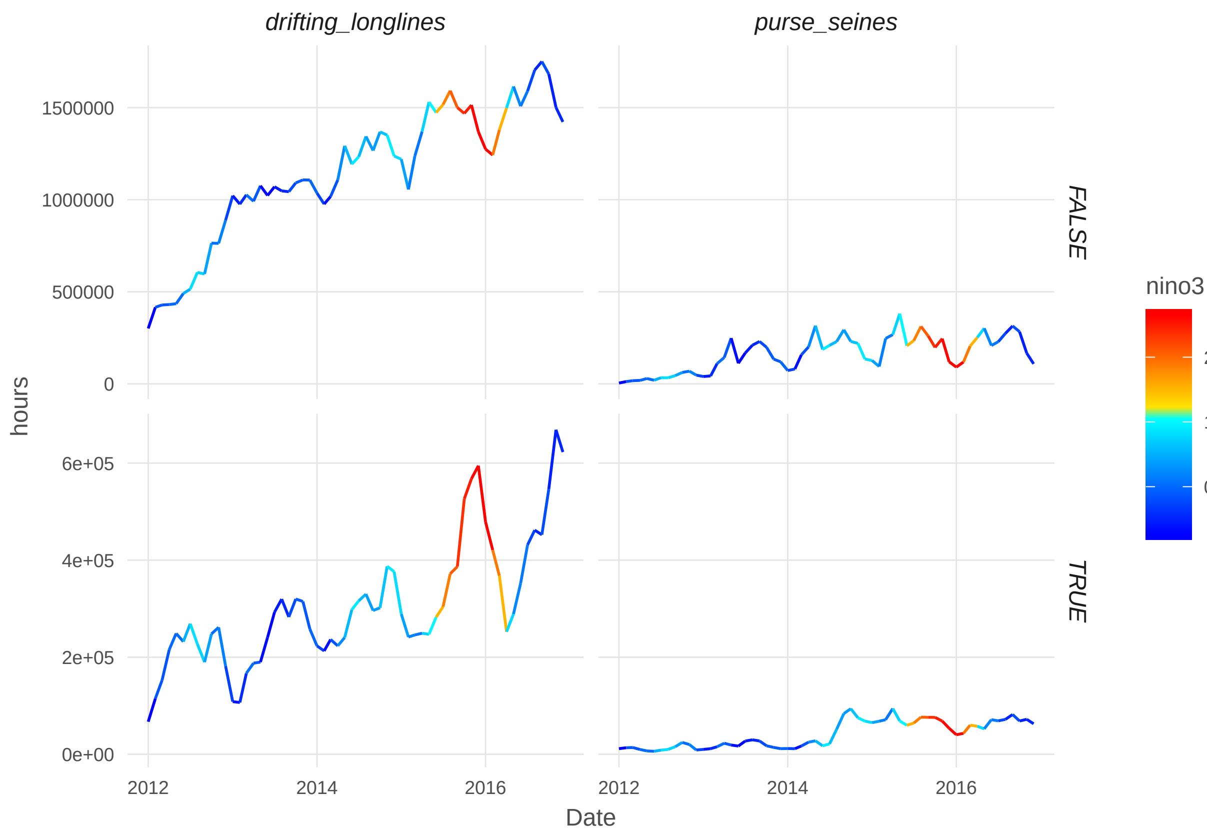

Figure 4: Trends in fishing hours by gear and foreign

We estimate the effects of ENSO on Foreign Fishing using a difference-in-difference strategy to compare the effects of ENSO on foreign fishing in regions impacted by ENSO to its effects on foreign fishing in regions not impacted by ENSO.

$$log(FF_{ct}) = \alpha + \beta ENSO_t \times \Pi_{c\epsilon T} + \phi_t + \lambda_c + \epsilon_{ct}$$

FF_{ct} represents the foreign fishing variable of interest by country and year. We use an inverse hyperbolic sine[1] of our foreign fishing variable in my main specification to transform zeroes in the data [Burbidge et al.,

[1] $ln(FF + \sqrt{1 + FF^2} \rightarrow ln(2L)$

1988, Card and DellaVigna, 2017]. α is a constant and β captures the linear effect of ENSO on countries in effected regions compared to counties in regions uneffected by ENSO. The treatment is ENSO interacted with a dummy, Π_{ct}, that equals 1 for countries in ENSO-effected regions and 0 for countries in uneffected-ENSO regions. ϕ_t are monthly fixed effects and λ_c are country fixed effects. Standard errors are clustered at the country level

Identify treatment regions

First we established a relationship between ENSO and two local environmental variables that drive the geographical presence of fish stocks, sea-surface temperature (SST) and windspeed. We use composite images of average monthly SST value, SST_t , from the NASA Dataset[2]. We run the following regression model:

$$SST_t = \omega + \phi ENSO_t + \sum_{p=1}^{N} \mu_p t^p + \epsilon_t$$

[2] ftp://podaac-ftp.jpl.nasa.gov/

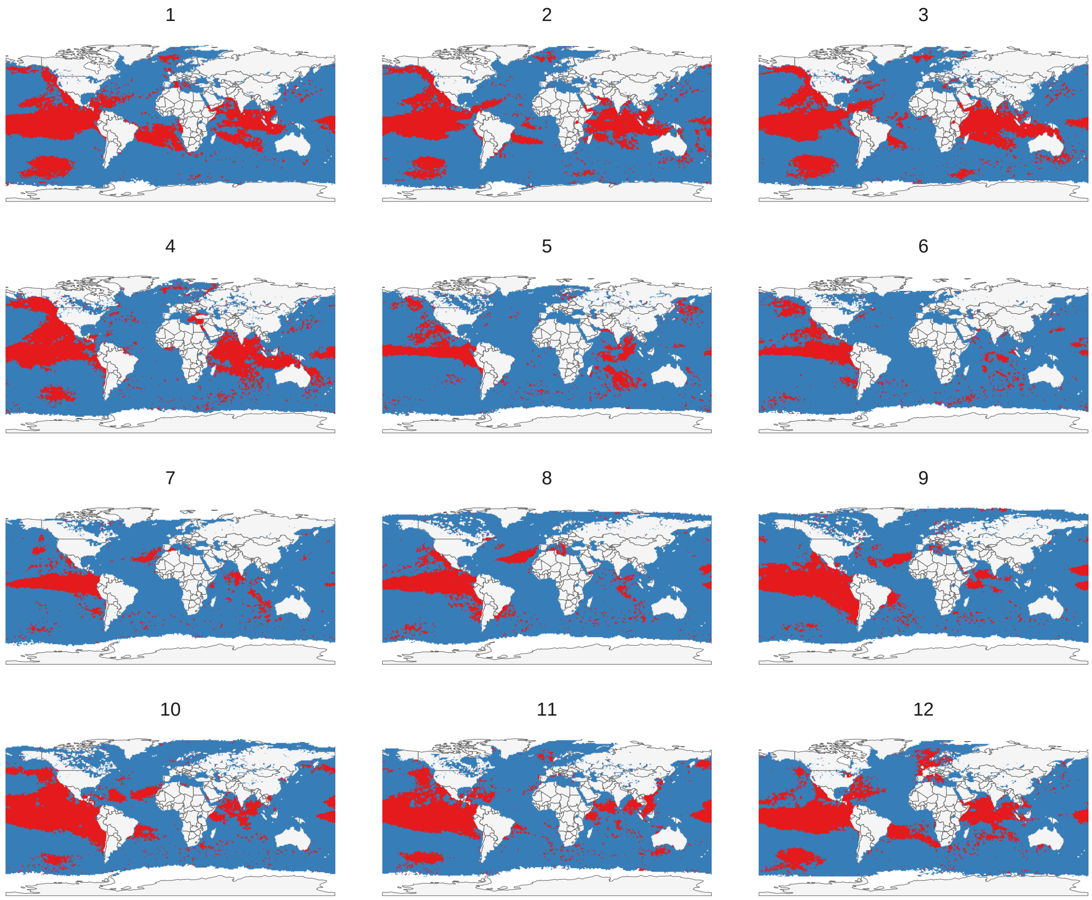

Figure 5: Monthly correlations between SST and nino3 index. Numbers above each pannel indicate the month (1 = Jan, 12 = Dec). Red zones indicate the pearson's correlation coefficient was > 0 and p < 0.1.

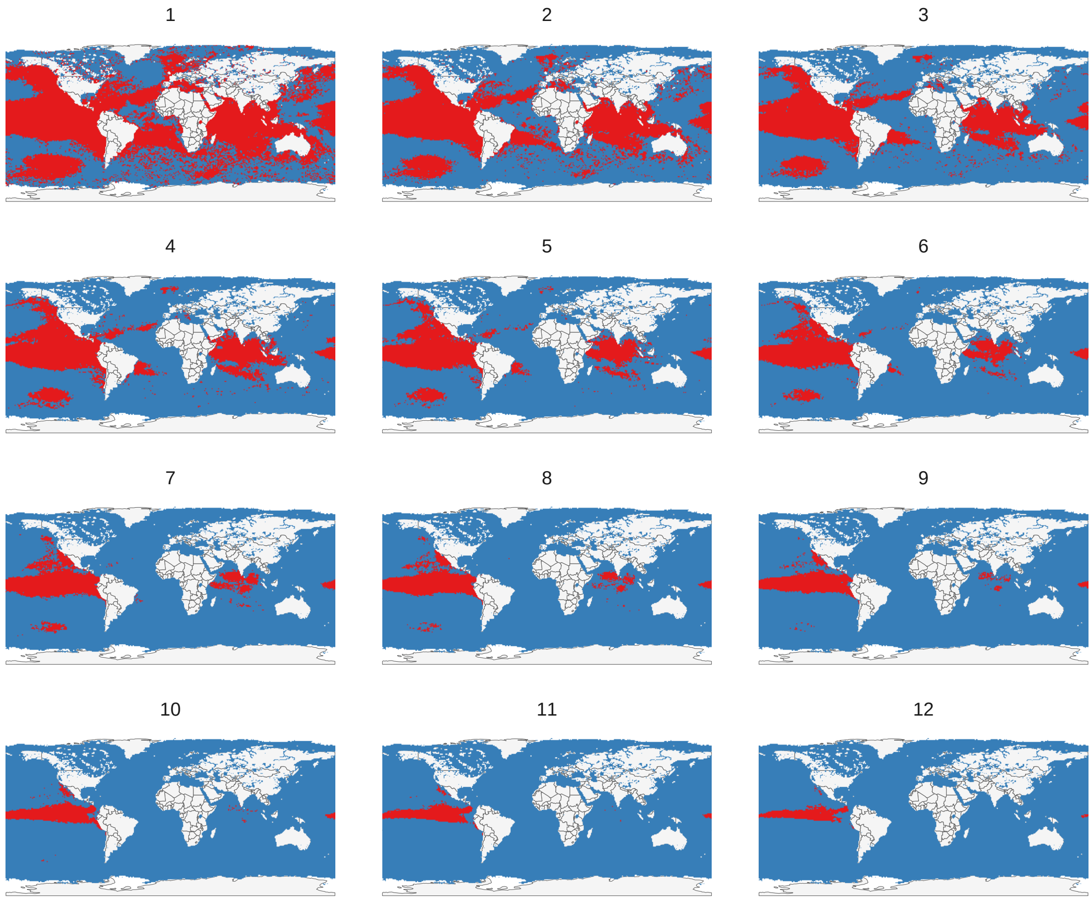

Figure 6: ENSO teleconnection depending on number of months. Number above figures indicate the minimum number of months for which a particular parcel was correlated to nino3 (red). For example, the panel 6 indicates that all red regions where SST showed a positive ($r > 0$) and significant ($p < 0.1$) correlation with nino3 index for at least 6 months.

where ω is a constant, ϕ captures the linear effect of monthly ENSO and μp captures the effect of a p$^{\text{th}}$-order polynomial time trend. Standard errors use the Newey-West adjustment which allows for serial correlation and heteroscedasticity of arbitrary form in the error terms over an optimally chosen window of time [Newey and West, 1987, 1994].

SST during this sample period exhibited trending behavior and thus needed to be detrended. To determine the polynomial order of the time trend, N, we use the Akaike Information Criteria (AIC) [Akaike, 1974], which when minimized captures a model's overall goodness of fit while penalizing additional terms with limited explanatory power. For both fisheries, we observe that the AIC statistic drops when a time trend of second-order or higher is included in Equation 2. Importantly, we detect a positive/negative relationship between winter ENSO and SST and a positive/negative relationship between winter ENSO and windspeed, shown in Figure X.

$$log(FF_t) = \psi + \delta ENSO_t + \sum_{p=1}^{N} k_p t^p + \mu_t$$

ψ is a constant; δ captures the linear effect of ENSO and k_p represents the effect of a p^{th}-order polynomial time trend. Standard errors use the Newey-West adjustment, allowing for arbitrary forms of serial correlation and heteroscedasticity in the error term with a bandwidth of 10 months. As a robustness check, we use different polynomial time trends to remove any long-term trends.

Results

So far these are only for eq 1.

Table 1: Foreign fishing hours and nino3

	Dependent variable:							
	hours				hours2			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
nino3anom	0.718***	0.748***	0.550***	0.315	0.047***	0.047***	0.036***	0.022
	(0.075)	(0.076)	(0.076)		(0.002)	(0.002)	(0.002)	
treated	−0.087	0.040	0.173	−1.046	0.097***	0.097***	0.105***	−0.003
	(0.113)	(0.107)	(0.109)		(0.004)	(0.004)	(0.004)	
nino3anom:treated	0.333***	0.216**	0.238**	0.701	0.010***	0.010***	0.012***	0.056
	(0.092)	(0.093)	(0.093)		(0.003)	(0.003)	(0.003)	
Constant	19.894***	19.502***	21.480***	21.383	3.030***	3.030***	3.181***	3.114
	(0.097)	(0.082)	(0.180)		(0.003)	(0.003)	(0.007)	
Gear FE	No	Yes	Yes	Yes				
Month FE	No	No	Yes	Yes				
Country FE	No	No	No	Yes				
Observations	418,458	418,458	418,458	418,458	418,458	418,458	418,458	418,458
R^2	0.001	0.002	0.004	0.019	0.005	0.005	0.010	0.053
Note:								*p<0.1; **p<0.05; ***p<0.01

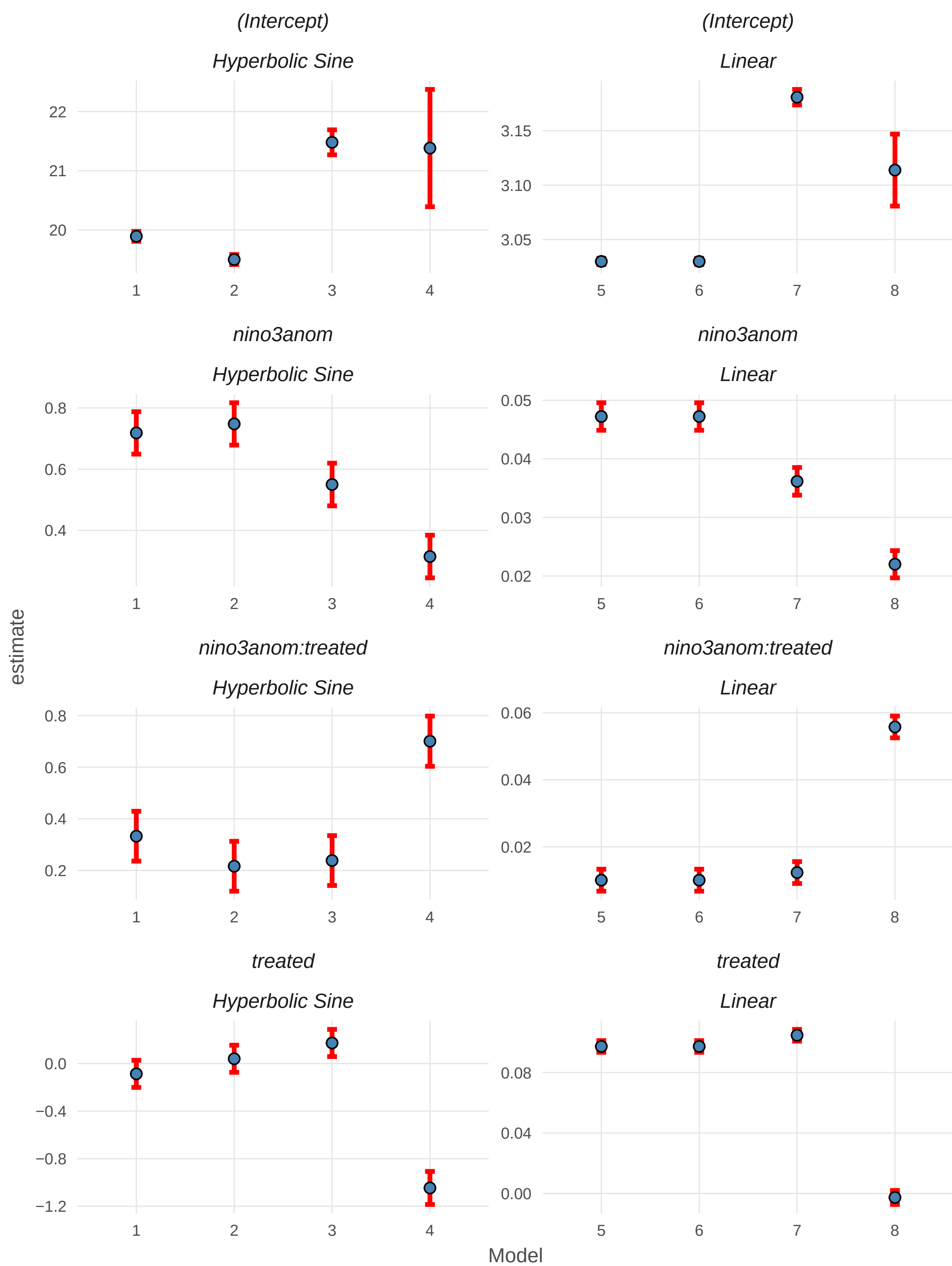

Figure 7: Coefficient estimates for the models ran above. Graphs on the left show estimates after the hyperbolic sine transformation of hours. Right side show no transformation of hours. Model numbers (x - axis) correspond to the columns in table 1 (1 - 4) and table 2 (5 - 8).

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