Appendix D5: Regulatory Impacts on Exit from the California Drift Gillnet Swordfish Fishery: A Treatment-Control Duration Model-Based Approach

Regulatory Impacts on Exit from the California Drift Gillnet Swordfish Fishery:

A Treatment-Control Duration Model Based Approach

NOAA FISHERIES
South West Fisheries Science Center

Fisheries Resource Division

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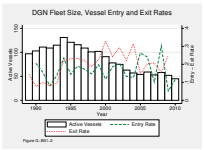
Protected Resources Workshop
Scripps Institute of Oceanography
September 10th, 2014

Background

- Drift gill net gear - sea turtle interactions
  - Leatherback Turtle Conservation Area (LTCA)
    - DGN prohibition in N. CA swordfish grounds: 8/15-11/15, 2001-present

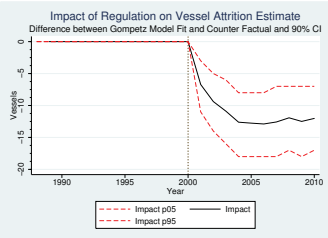


Motivation

- In Regulatory Analysis, including Cost / Benefit, we need to know the counter factual, the with or without
- What is the impact of the regulation?
  - Vessels
  - Landings

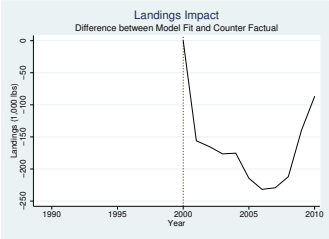
DGN Regulation Fleet Size Reduction Impact

- 11.4 fewer vessels annually



DGN Regulation Fleet Landings Reduction Impact

- Reduction of 179,000 lbs landings annually (28% from predicted)

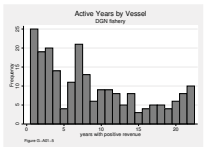


Application

- **Impact of regulation on DGN fleet size**
  - Duration analysis
  - Counter-factual estimated via treatment-control framework
  - Simulating participation decisions
- **Impact of regulation of fleet swordfish landings**
  - Reduced form analysis

Data

- Mandatory reporting CA DGN participants, 1989-2010
  - Vessel ID, port, fishing block, gear, & landings & revenue by species.
    - Pacific Fisheries Information Network: http://pacfin.psmfc.org/



Difference-in-Differences Framework

- Identify impact while controlling for confounding variables
  - Compare changes in variable of interest (hazard rates, landings) between pre- and post-treatment of treatment group to that of control group

$$Y_{itg} = \beta_1 T_{ig} + \beta_2 t_{it} + \beta_3 \mathbf{T_{ig}} \mathbf{t_{it}} + \lambda X_{itg} + \varepsilon igt \qquad (1)$$

  - Coefficient interpretation:
    - T_{ig}: treatment group specific effect
    - t_{it}: common time trend effect
    - $\mathbf{T_{ig}} * \mathbf{t_{it}}$: average treatment effect (ATE)
    - X_{itg}: additional controls and intercept

Identification Strategy

What is the treatment and treatment / control group?

- Regulation
  - Prohibits DGN gear in LTCA during peak season
  - Introduced prior to 2001 season (August)
  - No impact expected in 2000 and prior seasons
- Treatment Period
  - **2001 and following seasons**
- Treatment Group
  - Identification of vessel impacted is latent
  - Proxies:
    - **% revenue associated with fishing in LTCA (pre-closure)**
    - % landings associated with fishing in LTCA (pre-closure)
    - Homeport
    - Primary Landing Port

Model Estimation

Parametric Transition Rate Models

Direct estimation of the survival function as a known distribution

- Exponential, Gompertz, Weibull, Log Normal, and Log Logistic
  - Easily parameterized: continuous and/or multiple covariates
    - (vs. Kaplan-Meier - also modeled)
  - Shape parameter easily parameterized
  - Transition rate can vary over time,
  - Constant, increasing or decreasing monotonically, or U or $\bigcap$
  - Relaxes proportionality assumption (vs. Cox - also modeled)

Covariate Specifications

- Treatment, treatment group, ATE
- Additional vessel and time specific covariates
  - Vessel length, skipper age
- Improves model fit
  - LR test, chi2(5) test statistic
- ATE covariate statistically significant
  - 1% level for the Exponential, Gompertz and Weibull
  - 10% level for the Log Normal
  - N.S. at the 10% level: Log Logistic

Empirical Results

- 1994 Coast-wide Reg. = + : -> shorter participation spells
- % LTCA Rev. = - : -> longer participation spells
- Post-2000 treatment period is not statistically significant
- Gompertz shape coefficient = - : HR is monotonically decreasing w/ time
  - Entrants are more likely to exit than incumbents
- **ATE = + : Post LTCA Reg & High LTCA Rev % vessels -> shorter participation spells**
  - Average effect nearly doubles hazard rate

Placebo Check

- 1994 coast-wide regulation
  - Expected to impact all vessels in the fleet
    - Not differentially impact vessels most likely impacted by future LTCA
  - Interact Coast-wide Regulation Period (post-1994) with Treatment Group Proxies
    - Fail to reject $\neq 0$ at all standard significant levels for all models

Model Selection

- Model selection is important as it directly impacts the resulting parameterization of the fleet size counterfactual simulation
- Statistical methods.
  - Gompertz outperforms Exponential and Weibull models - AIC and BIC
  - LogNormal and Log-logistic outperform the Exponential family
    - LogNormal outperforming Log-logistic - AIC and BIC

Model Selection: Graphical

- Inspection of pseudo residuals
  - Predicted hazard rates & cumulative hazard rate
  - Corollary of an inspection of residuals of standard OLS models

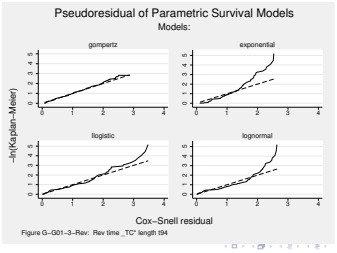


Figure G–G01–3–Rev: Rev time _TC" length t94

Fleet Population

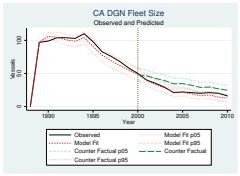
- Generation of a fleet size estimate
  - Under historic and non-regulation counter-factual conditions
  - Assumptions:
    - fleet entry is assumed exogenous
    - Hazard rate is not conditional on fleet size
    - Single episode of participation

Fleet Size Algorithm (2)

1. Define analysis-time at entry as $t_i = 1$ for each vessel i;
2. Calculate fitted hazard rate, $\hat{H}$ for each vessel & analysis time pair;
3. Draw $l * max(t_i)$ vector of uniform [0,1) distributed r.v., $\mathbf{U}$;
   1. Assign participation state:
      - If $u_{it} > \hat{H}_{it}$, vessel stays;
      - If $u_{it} \leq \hat{H}_{it}$, vessel exits (all remaining years);
   2. Count participating vessels by year;
4. Repeat Step (3)
5. Calculate mean, median, 5%, and 95% of sample for fleet size estimate

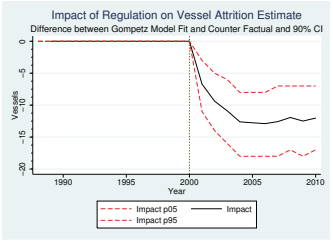
Fleet Size Estimate

Gompertz Based Parameters

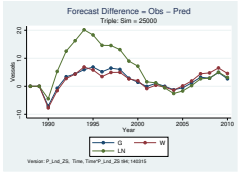


Regulation treatment effect reduced fleet size by roughly 11.4 vessels.

Impact of Regulation Estimate



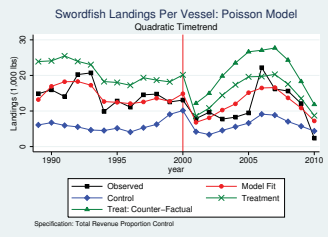
Specification Test Continued



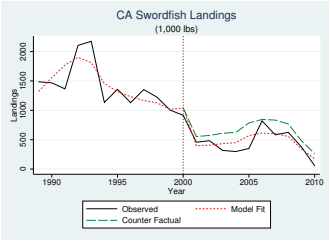
- Fitted fleet size robust to model specification post regulation
- Gompertz based fit outperforms alternative models
- Recall pseudo residuals

Landings Model

DGN Regulation Fleet Landings Reduction Impact



DGN Regulation Fleet Landings Reduction Impact



Summary

- Counter Factual Analysis is an important part of Cost Benefit Analysis
- Differential behavior by firms directly constrained by the regulation
- Supports H_0s that regulation increases hazard rate of exit
  - Counter-factual fleet size impact: 11.4 vessels
- Supports H_0s that regulation decreased landings
  - Counter-factual swordfish landings impact: 1.8 million lbs (10 years)
- Future Research
  - Model fishery/gear type entry decision

Important Note

Estimating the cost of regulation is only part of the analysis
Proper analysis also considers benefits

- WTP measures for recovery of turtle populations
  - Wallmo & Lew (Conservation Biology, 2012)

Thank you and Questions

- Many thanks to those that have commented or otherwise contributed to this research
- Questions?

Regression Results: w Covariates

Parametric Transition Rate Models

	Exp PH	Gompertz PH	Weibull AFT	LogNormal AFT	Loglogistic AFT
Length	-0.019***	-0.013*	0.019***	0.017**	0.015**
Coastwide Regulation	0.690***	1.012***	-0.901***	-0.994***	-1.129***
Rev	-0.475**	-0.410*	0.477*	0.338	0.372
treatment period	-0.716***	-0.342	0.721***	0.543*	0.450
Treatment	2.318***	1.991***	-2.450***	-1.721*	-0.876
Constant	-1.313***	-1.367***	1.387***	0.951***	1.002***
Shape		-0.084***	-0.113*	0.120**	-0.442***
Observations	1295	1295	1295	1295	1295
AIC	652.9	632.8	651.5	614.6	621.8
BIC	683.9	669.0	687.6	650.8	658.0
ll	-320.4	-309.4	-318.7	-300.3	-303.9

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Period	Obs.	Pred-G	CF-G	Diff-G	Pred-LN	CF-LN	Diff-LN
Pre-Reg.	80.8	78.1	78.1	0	72.1	72.1	0
Post-Reg.	24.5	22.4	33.9	-11.4	16.9	31.9	-15.0

Hazard Model

Observed, Fitted, Counter-factual

Season	Obs	Pred-G	CF-G	Diff-G	Pred-LN	CF-LN	Diff-LN
1989	97	97	97	0	97	97	0
1990	99	106	106	0	103	103	0
1991	104	105	105	0	99	99	0
1992	104	101	101	0	92	92	0
1993	103	99	99	0	87	87	0
1994	110	104	104	0	91	91	0
1995	98	91	91	0	81	81	0
1996	83	78	78	0	70	70	0
1997	76	70	70	0	64	64	0
1998	68	62	62	0	57	57	0
1999	58	55	55	0	51	51	0
2000	50	49	49	0	45	45	0
2001	40	39	46	-7	33	43	-10
2002	35	33	42	-9	27	40	-13
2003	29	28	39	-11	22	37	-15
2004	21	22	34	-13	16	33	-17
2005	22	22	35	-13	16	33	-17
2006	21	20	32	-13	14	30	-17
2007	20	16	29	-13	11	27	-16
2008	21	18	30	-12	123	28	-15
2009	20	14	26	-13	10	25	-15
2010	16	13	25	-12	8	23	-14