Evaluating the Impact of Sector Management on the Productivity of New England Groundfish Fisheries

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Policy background

- Common Pool in the New England groundfish fisheries
  - Allocation of days at sea
  - Area closures
  - Gear restricted areas
- Sector management: right-based approach

New regime in the New England groundfish fisheries

- Started from May 1, 2010
- 9 of 13 groundfish species are managed
- Voluntarily formed sectors
- Annual catch limits (ACLs)
- Annual Catch Entitlements (ACEs)
- Each member has the potential sector contributions (PSC) to the sector's ACEs
- Based on their catch history for a fixed period (1996-2006)
- ACEs transferable within the sector and across sectors
- Joint liability
- Overage could impact next year's ACEs and lead to penalties

Figure: Total catch over half years

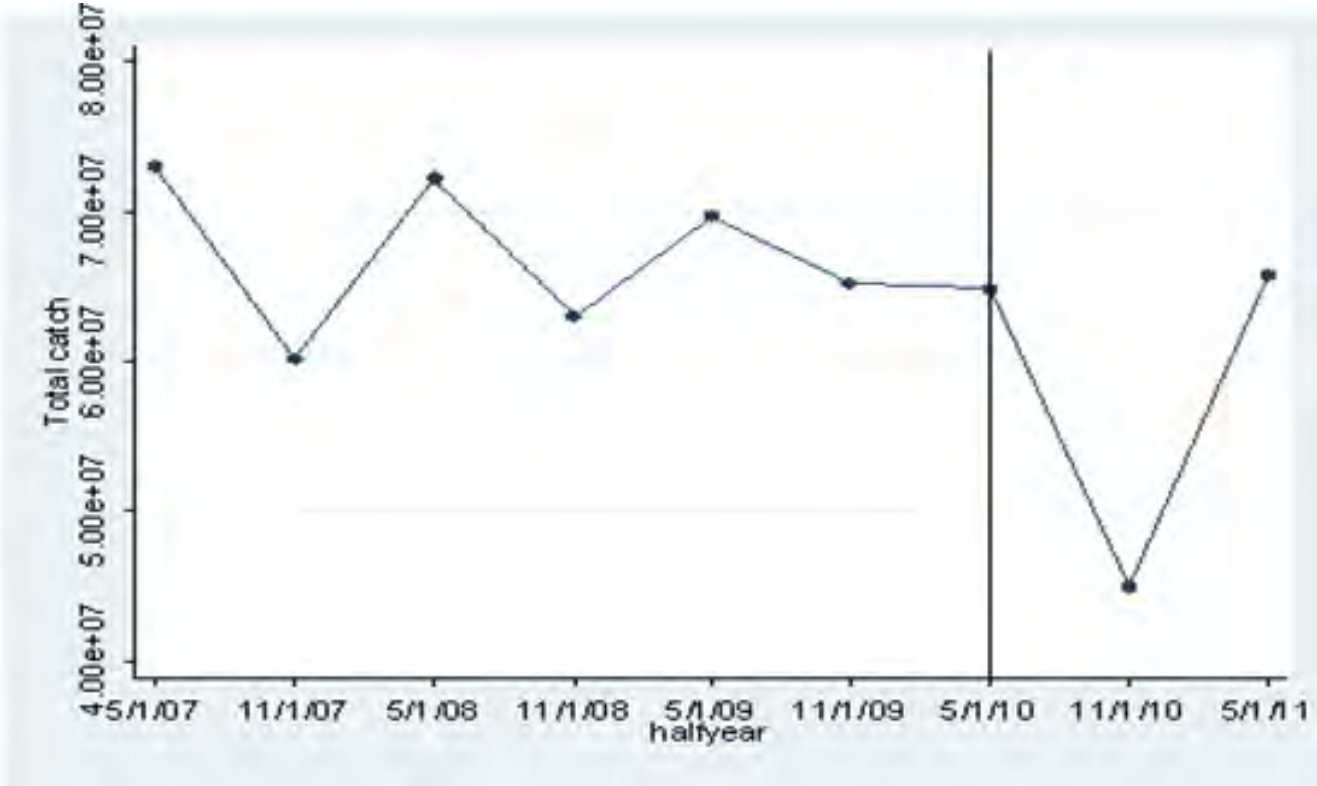
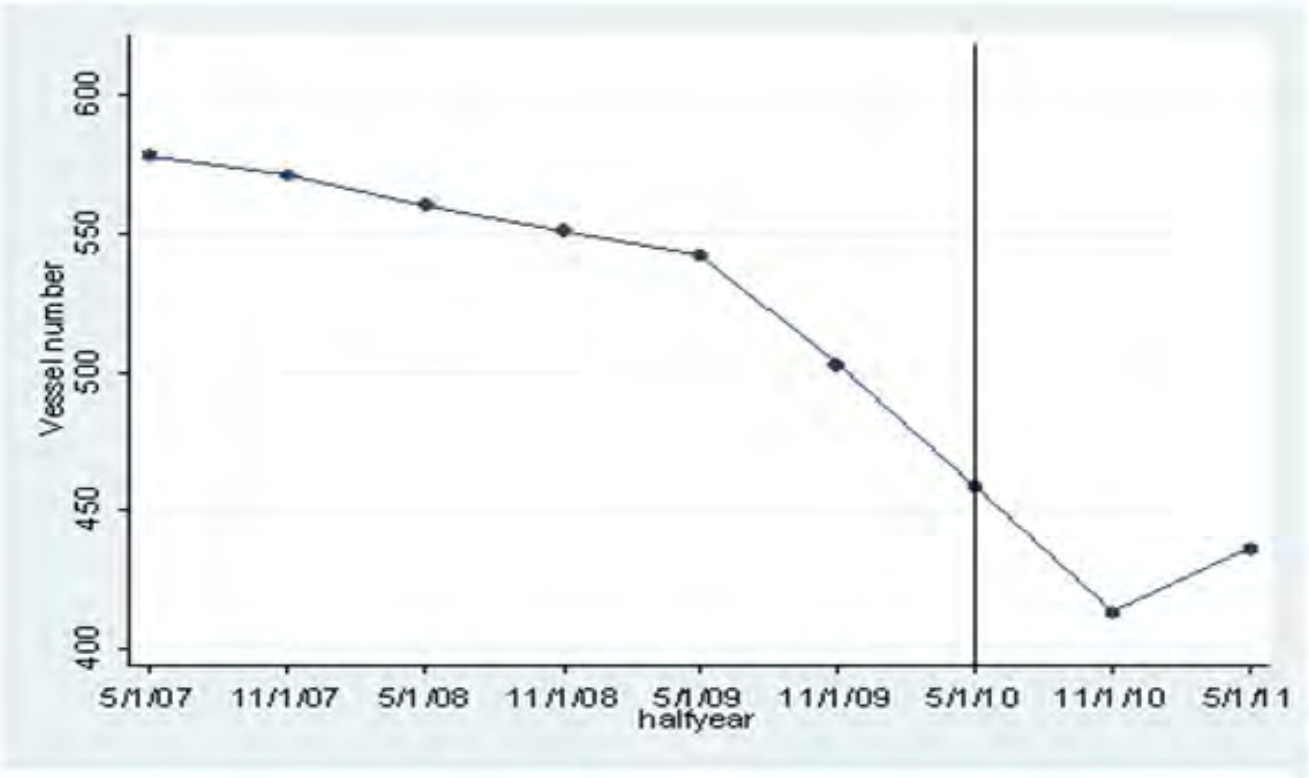


Figure: Active vessel number over half years



Research outline

- Objective: to evaluate the impact of new regime on the productivity of New England groundfish fisheries
- Methodology: Stochastic Production Frontiers (SPF)

Literature review

- A recent survey by Morrison Paul et al. (2010)
- Two primary methods: productivity indices and frontiers
- Total factor productivity (TFP) measurement for the Pacific Coast trawl fishing industry (Squires, 1992)
- TFP in the New England groundfish fishery (Jin et al., 2002) (TFP increased from 1964 to 1982, but declined from 1983 to 1993 mainly due to more stringent output and effort controls.)
- Productivity change in the Mid-Atlantic surfclam and ocean quahog fishery under ITQ management (Walden et al., 2012) (productivity increased immediately after ITQ implementation, but the gains were not sustained for multiple reasons)

Stochastic Production Frontiers (SPF) Model

- A general SPF production model

$$y_{it} = y_{it}^{*} e^{-u_{it}}, u_{it} \geq 0 \tag{1}$$

- For multi-species

$$y_{it1} = e^{f(\frac{y_{it2}}{y_{it1}}, \frac{y_{it3}}{y_{it1}}, \ldots, \frac{y_{itK}}{y_{it1}}, x_{it}; \beta) + \varepsilon_{it}} * e^{-u_{it}}, u_{it} \geq 0 \tag{2}$$

  - y: output
  - i: individual vessel i
  - t: time
  - x: input

- Technical Efficiency

$$TE_{it} = e^{-u_{it}} \tag{3}$$

$$TE_{i} = E[e^{-u_{it}} | \varepsilon_{it}] \tag{4}$$

- Two-step estimation
  - First-step: Battese and Coelli (1988)
  - Second-step: Regress TE on sector participation

Main Dataset

- Logbook data from 2007 to 2011 for the New England groundfish fisheries
  - weight of catch
  - price by species and trip
  - catch region by vessel, species and trip
  - trip length
  - crew size
  - gear type by vessel and trip and location
- Individual vessel characteristics
  - Vessel tonnage
  - Vessel size
  - Vessel power

Summary statistics

Variable	Mean	Std. Dev.	Min	Max
group 1 catch	2370.30	6117.29	0	131557.00
group 2 catch	447.67	1819.99	0	45714.01
group 3 catch	1296.75	4616.22	0	418112.40
group 4 catch	782.93	10394.08	0	2547079.00
Total catch	4897.64	13801.01	1	2547079.00
Vessel tonnage	36.39	36.14	1	201.00
Vessel size	46.39	12.55	9.75	107.00
Vessel power	360.85	173.51	1	2000.00
Crew number	2.36	0.94	1	55.00
Trip length	0.97	1.73	0	23.94

Result from the first-stage

Frontier	Coef.	Std. Err.	Frontier	Coef.	Std. Err.
ln(catch2/catch1)	-0.21***	0.00	lnt*location 3	-1.47***	0.263
ln(catch3/catch1)	-0.13***	0.00	$(lnt)^2$*location 3	1.31***	0.17
ln(catch4/catch1)	-0.29***	0.00	$(lnt)^3$*location 3	-0.42***	0.04
ln(Vessel tonnage)	0.18***	0.01	$(lnt)^4$*location 3	0.04***	0.00
ln(Vessel length)	0.94***	0.06	lnt*location 4	-1.91***	0.27
ln(Vessel power)	-0.06***	0.01	$(lnt)^2$*location 4	1.73***	0.17
ln(Crew size)	0.46***	0.02	$(lnt)^3$*location 4	-0.51***	0.04
ln(Trip length)	1.09***	0.01	$(lnt)^4$*location 4	0.05***	0.00
lnt*location 1	-0.02	0.27	Gear 2	-2.87***	0.04
$(lnt)^2$*location 1	0.96***	0.17	Gear 3	-0.39***	0.02
$(lnt)^3$*location 1	-0.30***	0.04	2008	0.31***	0.02
$(lnt)^4$*location 1	0.02***	0.00	2009	0.22***	0.02
lnt*location 2	0.81	0.69	2010	0.05**	0.02
$(lnt)^2$*location 2	-0.07	0.50	2011	-0.38***	0.02
$(lnt)^3$*location 2	-0.03	0.12	Constant	-0.94***	0.25
$(lnt)^4$*location 2	0.00	0.01			

Figure: Distribution of TE over half years

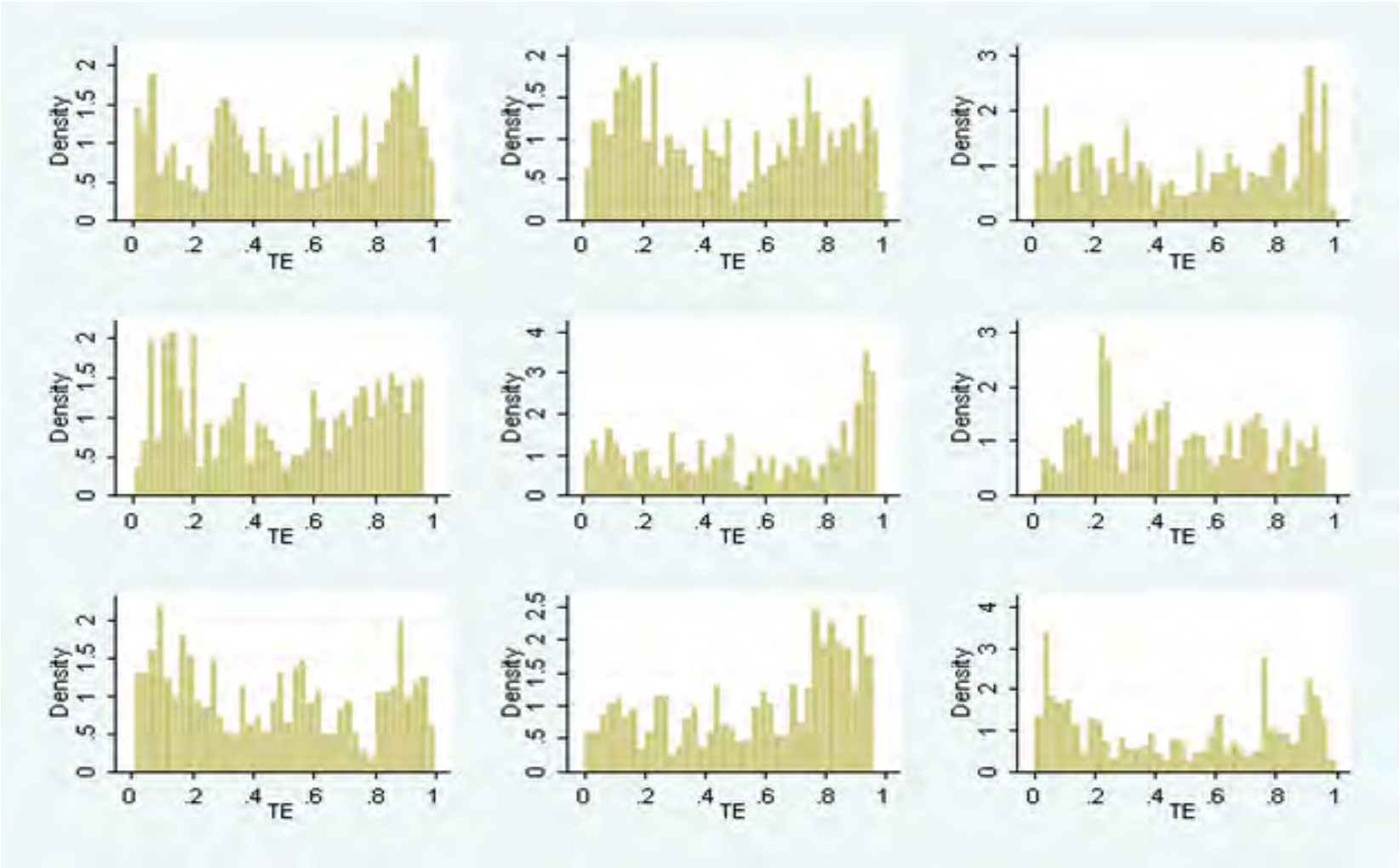
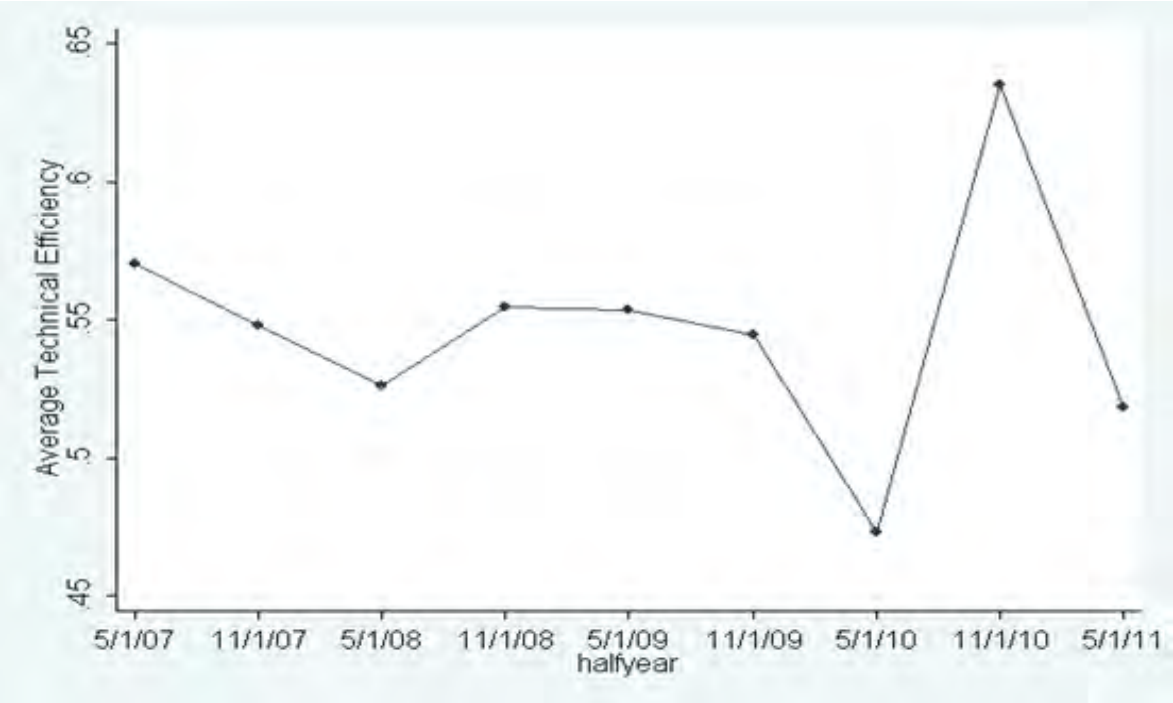


Figure: Average Technical Efficiency over half years



Sector participation

Model 1			Model 2		
Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Sector	0.07***	0.01	sector 2	-0.12	0.02
cons	-1.04***	0.00	sector 3	0.37	0.03
			sector 4	0.12***	0.03
			sector 5	-0.20***	0.04
			sector 6	0.36***	0.08
			sector 7	0.26***	0.02
			sector 8	-0.11*	0.06
			sector 9	-0.01	0.02
			sector 10	0.34***	0.02
			sector 11	-0.34***	0.02
			sector 12	0.21***	0.04
			sector 13	0.35***	0.04
			sector 14	0.11***	0.02
			sector 15	-0.74***	0.07
			sector 16	0.09	0.07
			sector 17	-0.77***	0.07
			cons	-1.04***	0.00

Conclusion

- Joining sectors increases productivity by 5.3% on average
- Sectors have different technical efficiency impact
- Technical efficiency impact of sectors changes over time

Further work

- Use data for 2012
- Different specifications
- Data Envelopment Analysis
- Multi-product Revenue Function