Atlantic Herring MSE: Economic Methods

Min-Yang Lee, NEFSC NMFS

MSE Peer Review
March 13-15, 2017

Outline

Refresher

Stakeholders identified many objectives and performance metrics.
Economic objectives identified at the first workshop:

Objective	Performance Metric
Maximize Yield for the herring Fleet	Yield
Maximize Profit for the herring fleet	Net Revenues
Ensure herring catch temporal stability	“Stability”

The Dream: An Economic Framework

Convert the effects of control rules on 4 user groups to dollars:

1. Users of landed herring (Demand)
   - Lobster industry, aquariums
2. Herring harvesters (Supply)
3. Direct users of herring in the ocean[1]
   - Terns and Whales
   - Striped Bass, Dogfish
4. Indirect users of herring in the ocean[2] (Derived Demand)
   - Bird- and whale-watchers
   - Recreational and Commercial Fishing

[1] not people
[2] people

Users of Landed Herring (demand)

Demand for herring probably depends on:

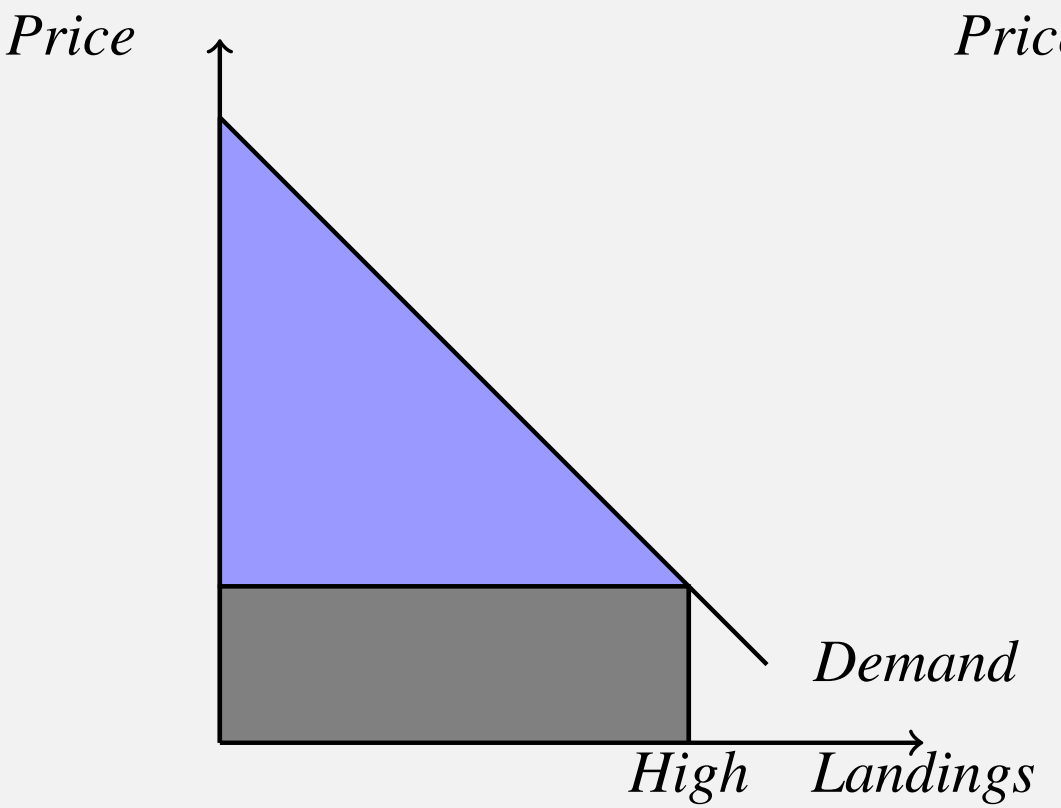
- Time of year
- Prices of Substitutes: Menhaden, racks, squid, other aquarium food
- Lobster effort prices and costs (fuel)

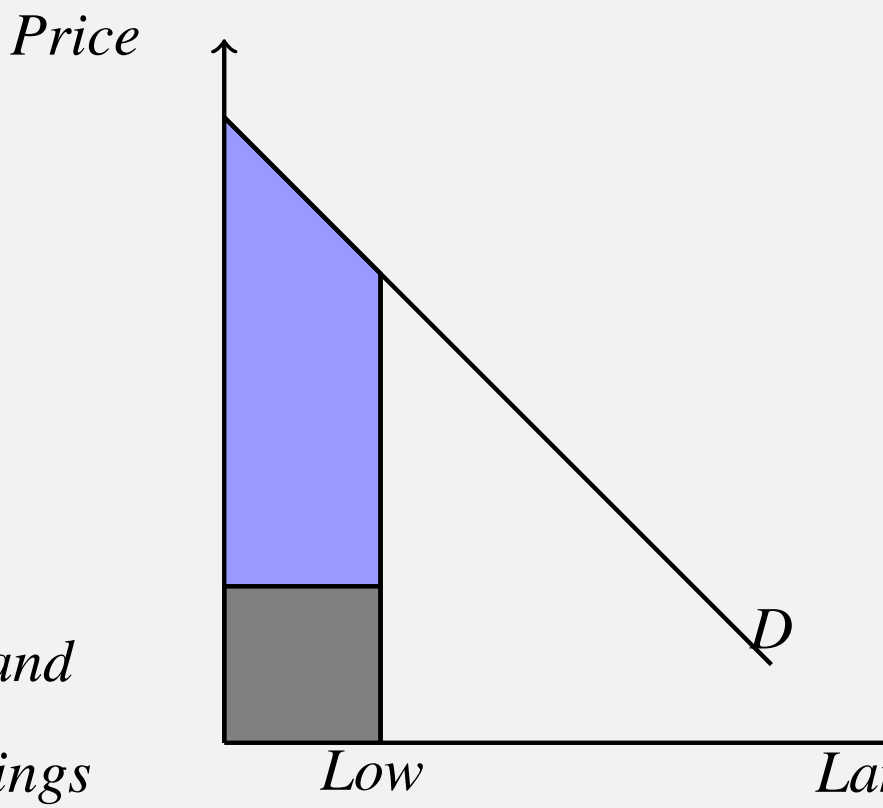
Demand: Why bother?

- Include the utility of consumers in the decisionmaking[3].
- Estimate prices and therefore revenues for the herring fishery

[3] "Maintain steady lobster bait supply"

Demand





Consumer Happiness and Producer Revenues

Supply

In the Short-Run

- Landings in a year may not be equal to yield (or the ACL)
  - Low herring prices or high fuel prices
  - Bycatch or “joint” catch
  - A fraction of the Unharvested yield will survive to the next year

In the Long-Run

- There is some “latent” effort (40+ permitted, 20+ active)
  - What would cause that latent effort to re-enter the fishery?
  - What would cause more vessels to leave?
  - Depends on “fixed” costs, and a permit-holder’s prediction about the future of the fishery

Supply, cont'd

- Vessels in a particular fleet (Seine, Trawl) are not identical
  - Some are "more integrated" with processors, some less
  - Some operate in pairs, others single
  - Some captains, crew are more experienced

Supply: Why bother?

- Predict landings and therefore gross revenues for the herring fishery
- Predict costs and therefore net revenues for the herring fishery
- Accurate estimate of entry and exit

Direct and Indirect Users of Herring in the Ocean

- “direct users of herring” (Gaichas and Deroba)
- How much does “predator consumption” cost the herring fishery (Flaaten and Stollery, 1996)?
- How changes in herring biomass affect another commerical fishery (Brown, Berger, and Ikiara, 2005)?

Users in the Ocean: Why bother?

- Put the non-extractive uses on the same scale (dollars) as the herring fishing
- Clarifies the tradeoffs, makes them more transparent
- More employment for economists

The Reality: Economics in this MSE

1. Users of landed herring (Demand)
   - Investigated demand for herring, but did not end up with a reasonable model
   - Assume a constant elasticity of -0.5
   - Drawback: Interpret Gross Revenues as a “Sensitivity Analysis” relative to the yield metric
2. Herring harvesters (Supply)
   - 2 fleets of homogenous vessels
   - No fixed costs
   - No entry or exit
   - Quantity supplied equal to yield
   - Drawbacks: Many

The Reality: Economics in this MSE

3. Direct users of herring in the ocean
   - Modelled ecologically, not modelled economically
   - Drawback: tradeoff plots proliferate
4. Indirect users of herring in the ocean (Derived Demand)
   - Not modelled
   - Drawback: Cannot convert the effects of changes in herring biomass into changes in utility of striped-bass anglers or spiny dogfish fishery participants.
   - Drawback: the “target species” itself becomes the measure for the indirect users

Refresher

Stakeholders identified many objectives and performance metrics.
Economic objectives identified at the first workshop:

Objective	Performance Metric
Maximize Yield for the herring Fleet	Yield
Maximize Profit for the herring fleet	Net Revenues
Ensure herring catch temporal stability	“Stability”

Performance Metric: Yield

Jon talked about this already.

Performance Metric: Net Revenues

- Build a simple model of the commercial herring industry
- Net Revenue = Price*landings-Cost of landings
  - Yield=landings

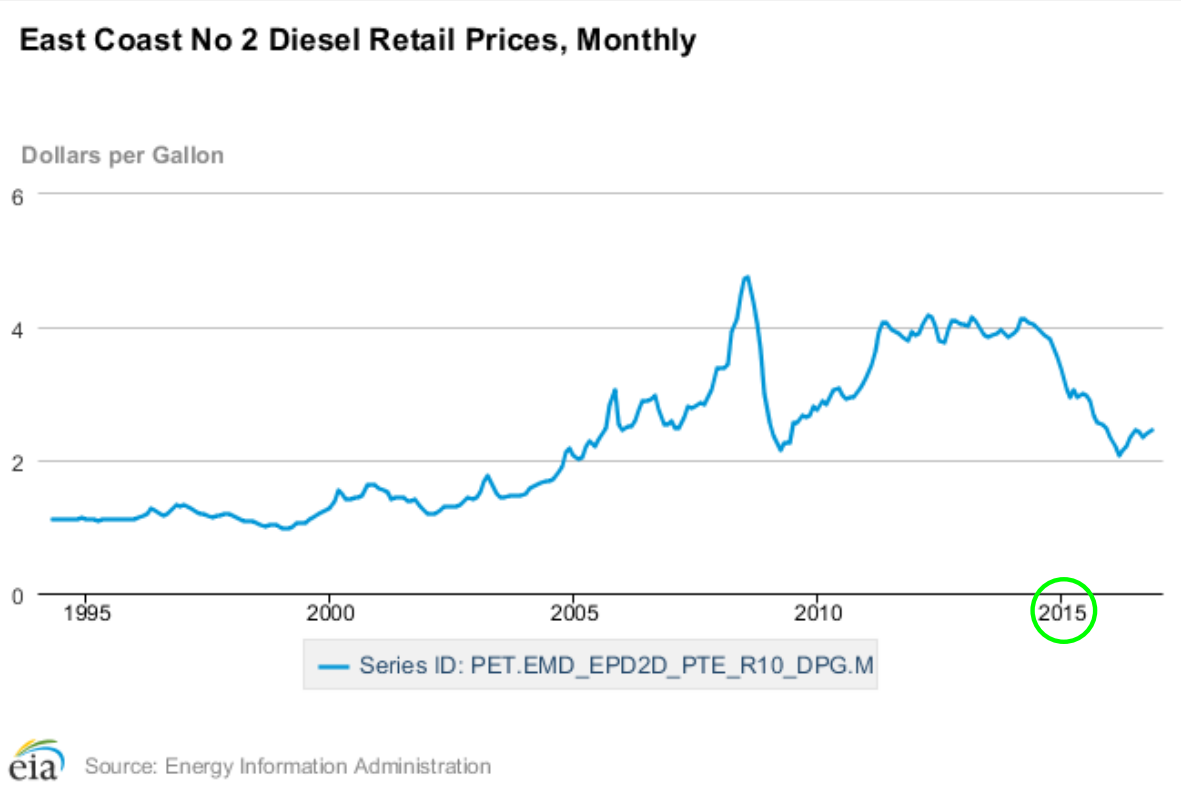
Costs

- Two fleets (Purse Seine and Trawl).
- Divide the Yield historically (30% Purse).
- Assume Yield=landings=catch
- Catch per day is similar for both fleets, but length of trips, number of trips, and costs per day differ[4].

[4] NEFOP observed trips

Costs

- Based on data on operating costs collected through NEFOP.
- Fuel, Damage, gear, ice.
- no labor payments OR “supply costs”
- 2015 data only because...



We could evaluate the sensitivity of the results to the “high cost” time period.

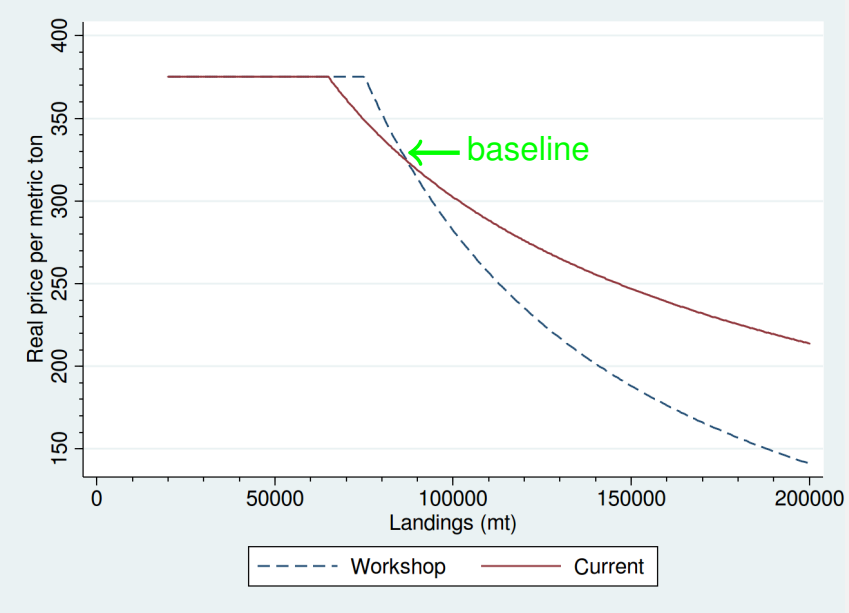
Other costs

MAFMC collected information from the “small pelagics” fleet many aspects of costs, including crew shares and fixed costs, to inform development of Industry Funded Monitoring amendment to many FMPs.
NEFSC-SSB collects some information as part of an occasional survey.
Not included in this analysis.
Drawbacks:

- Fixed Costs:
  - Without a model of entry or exit: Net revenues are all overstated by the same amount (Fixed cost of the fishing fleet)
  - If a model of entry/exit were added, Fixed Costs **must** be included.
- Crew Shares: Same drawback applies.

Price

- When landings go up, prices go down.
- When landings are very low, consumers switch to menhaden.
- Menhaden: $227 per mt at the dock plus $133 per mt to transport.
- Based on 2011-2015 data.



Performance Metric: Net Revenues

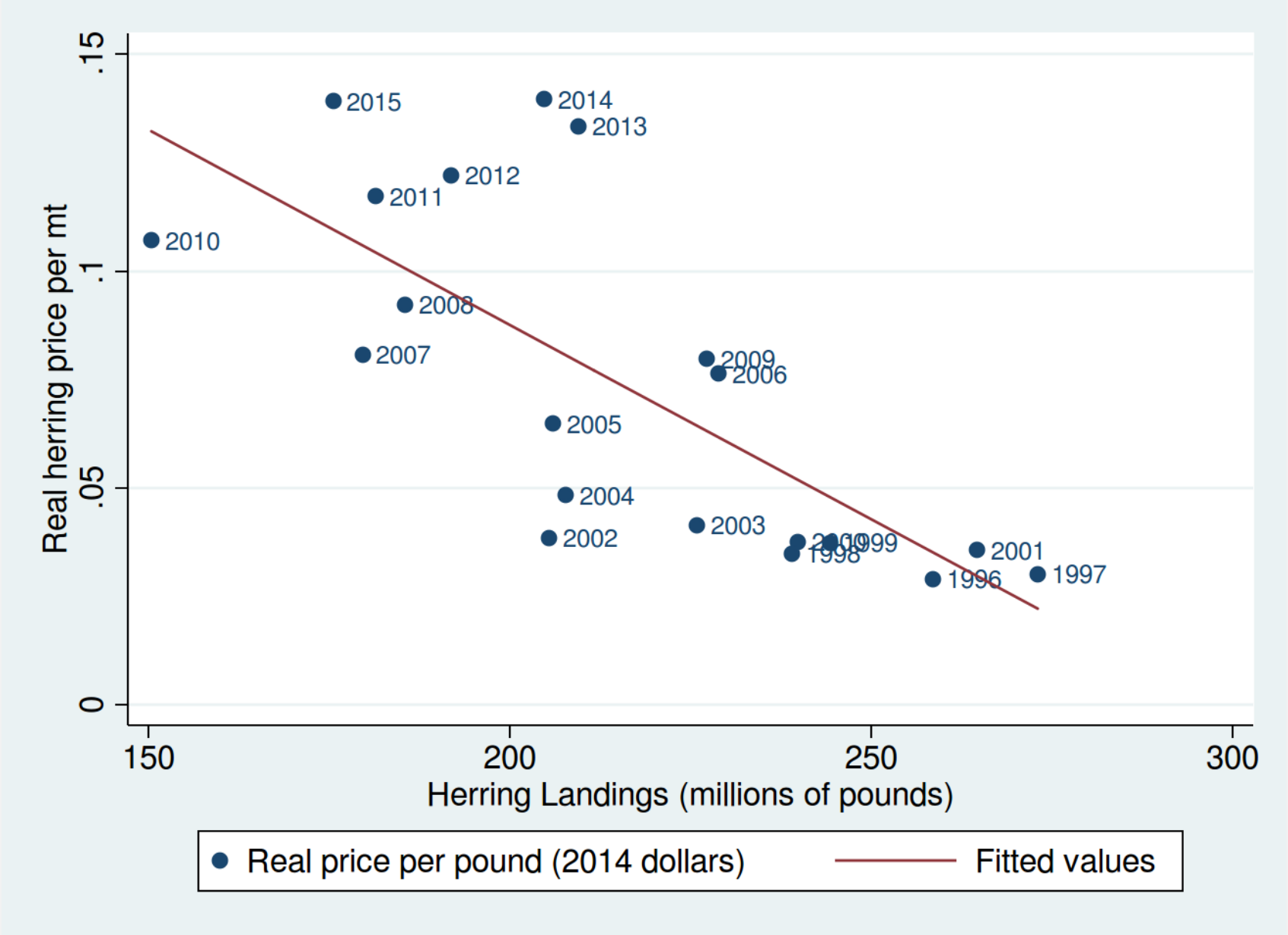
Net Revenue = Price*Yield-Costs

Prices, another approach

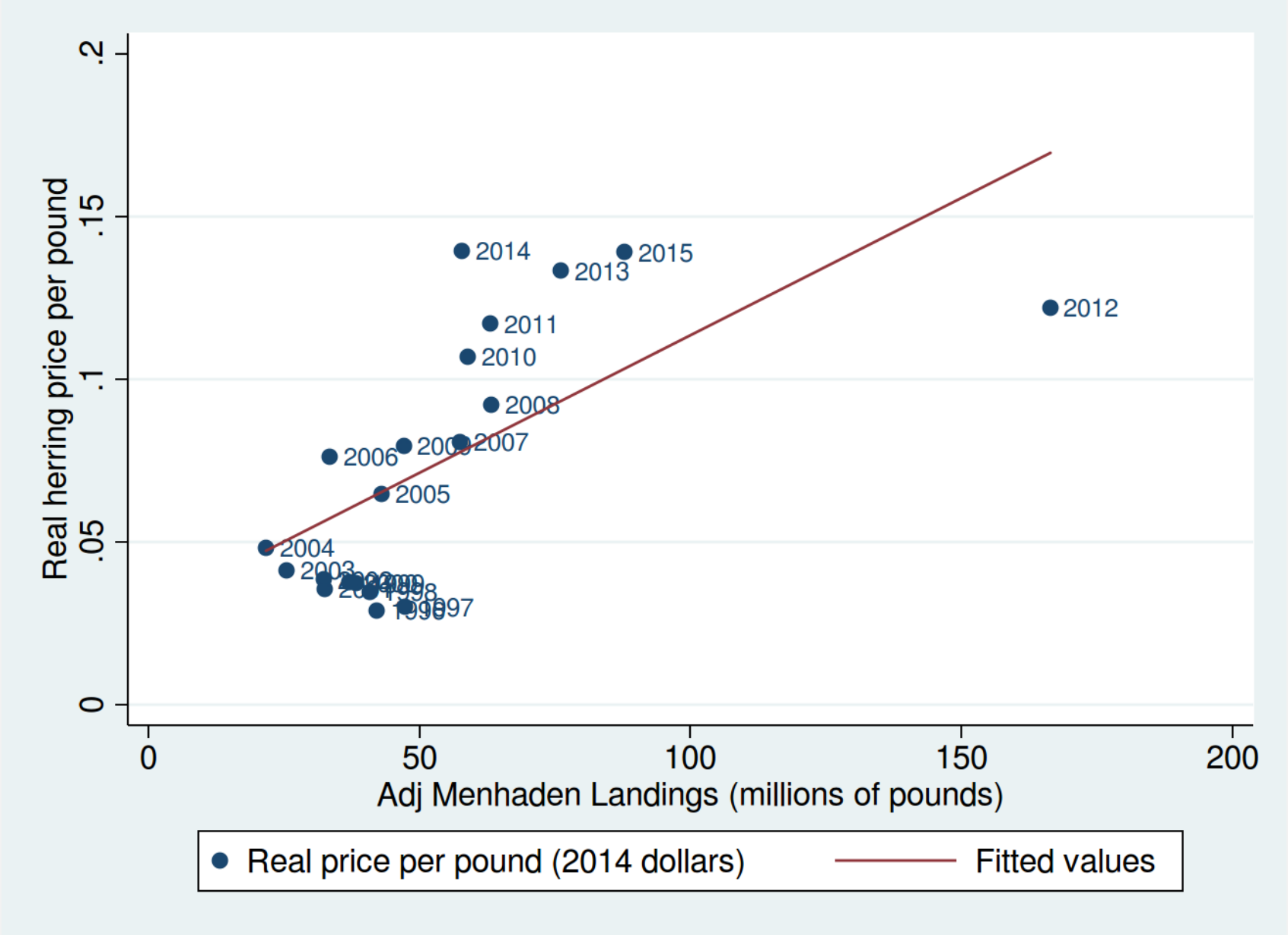
- Tried to build an econometric model of prices (demand for) of herring.
- Didn't get anything to work after a while, and we needed to get something done[5]
  - Simple annual models: mis-specified (autocorrelation)
  - "complicated" annual models: imprecise or implausible parameter values

[5] Since the workshop, I've done a little more analysis, and might be able to estimate a reasonable model

Real Herring Prices



Herring and Menhaden



Performance Metric: Stability

Many ways to think about the concept of stability:

- How “streaky” is Net Revenue?
- Do you get “runs” of bad outcomes and “runs” of good outcomes?
- How “persistent” are good and bad years?
- If this year was better than average, is next year likely to be better than average?

Performance Metric: Stability

Time series stationarity (Dickey and Fuller, 1979) as a measure of stability.

- If Net revenue is governed by a unit-root, then “shocks” are permanent
- If shocks are permanent, we don’t have a “mean.”
- If shocks are permanent, then we don’t have mean reversion or an equilbrium of this performance metric
- Stationarity is a characteristic of the “process”, so we don’t have to do medians of medians.

Performance Metric: Stability

Requires some judgement about how to model the time series

$$NR_y = a + \rho NR_{y-1} + \delta y + u_y \tag{1}$$

$$\Delta NR_y = \beta NR_{y-1} + \delta y + \sum_{j=1}^{3} \xi_j \Delta NR_{y-j} + \varepsilon \tag{2}$$

Should we include a time trend? How many ΔNR_{y-j} should be included?

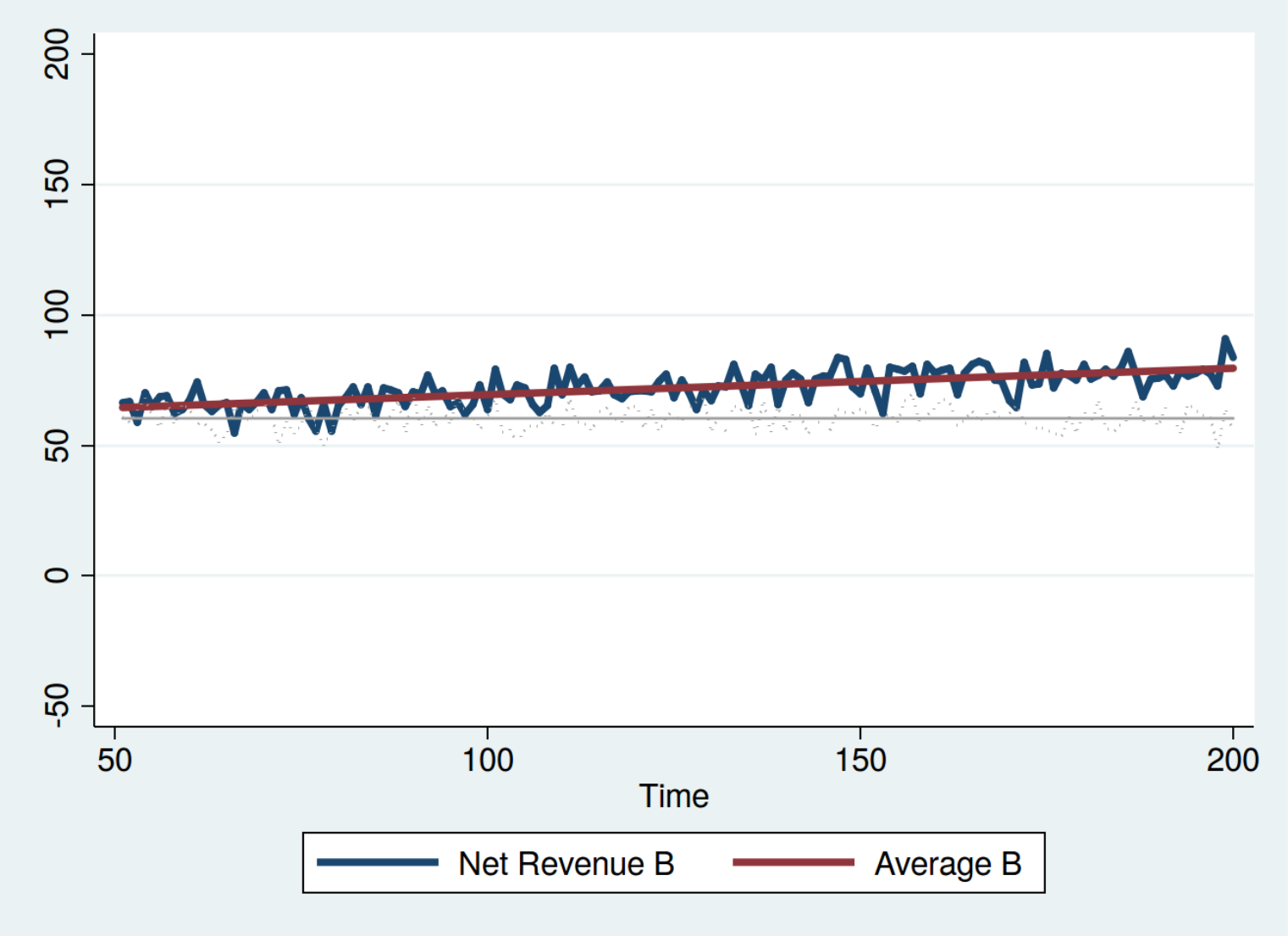
- If $\beta \neq 0$, then the process is stationary.
- If I reject the hypothesis that $\beta = 0$ with some amount of certainty, then the process is stationary.

Performance Metric: Stability

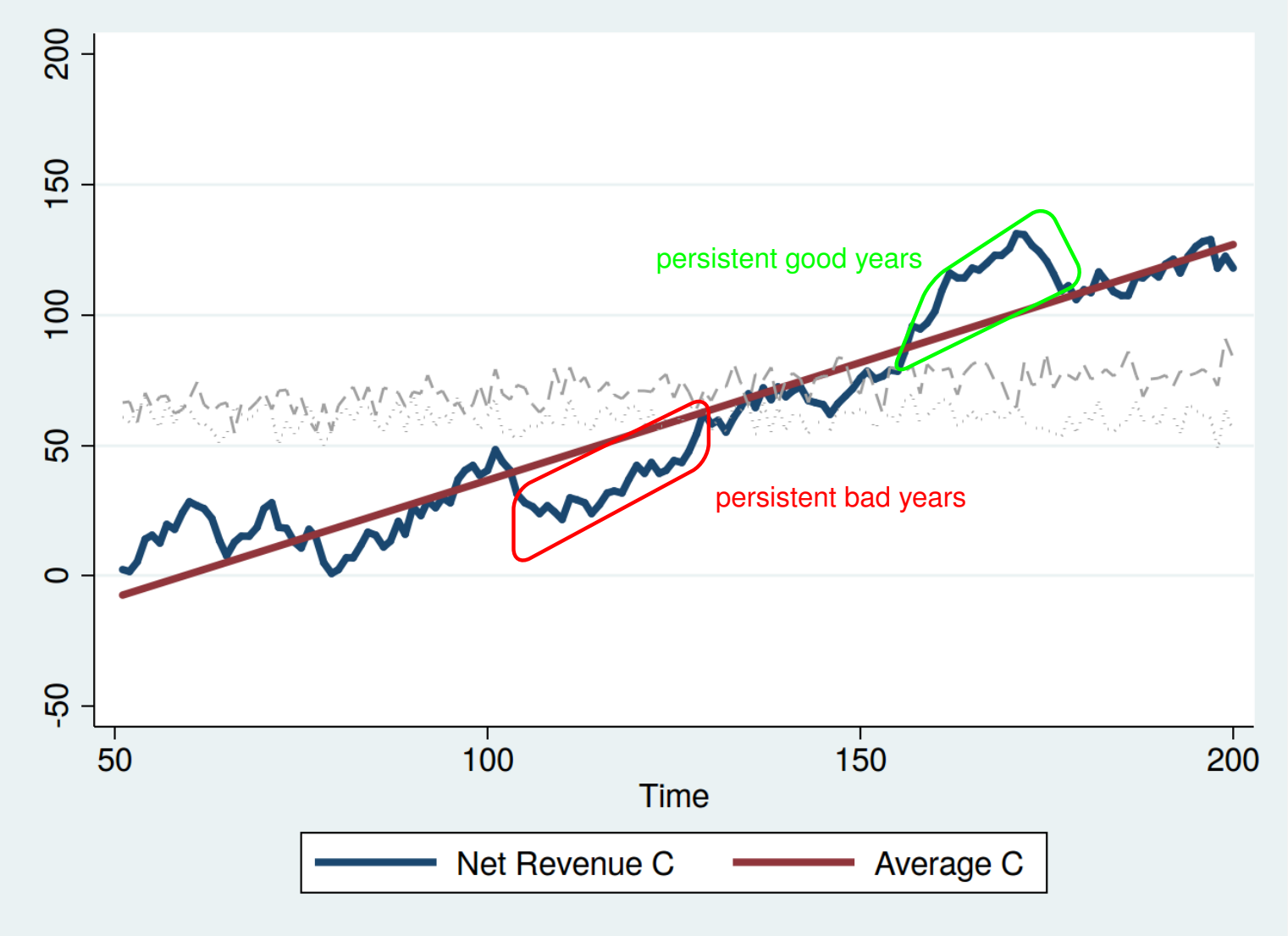
$$\Delta NR_y = \beta NR_{y-1} + \delta y + \sum_{j=1}^{3} \xi_j \Delta NR_{y-j} + \varepsilon$$

- Since the 3yr and 5yr policies produce yields that are pretty similar within each “block”, I probably should have accounted for this by either:
  - Picking 1,3, and 5 for the ΔNR_{y-j} depending on the policy simulation, or
  - Collapsing these blocked intervals to a single unit of time

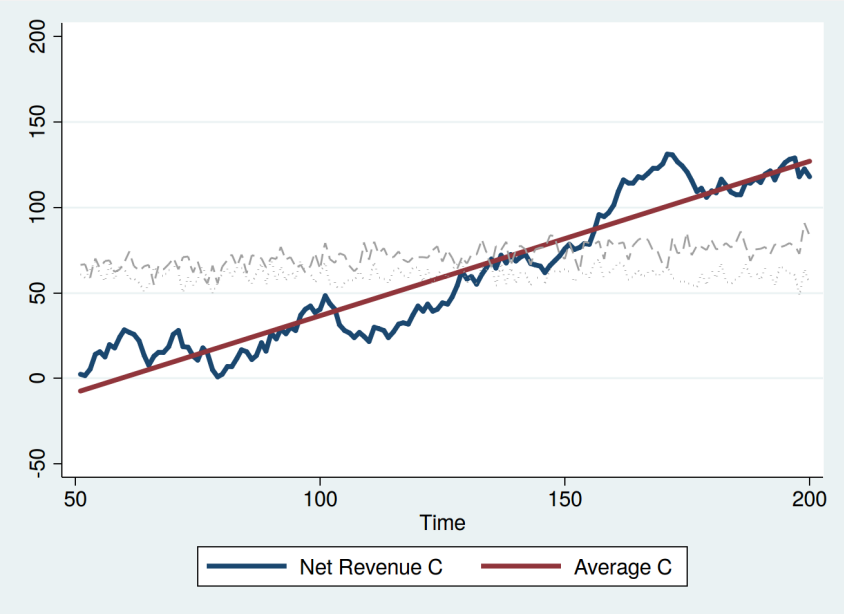
An example of “Stable”



An example of “Streaky”

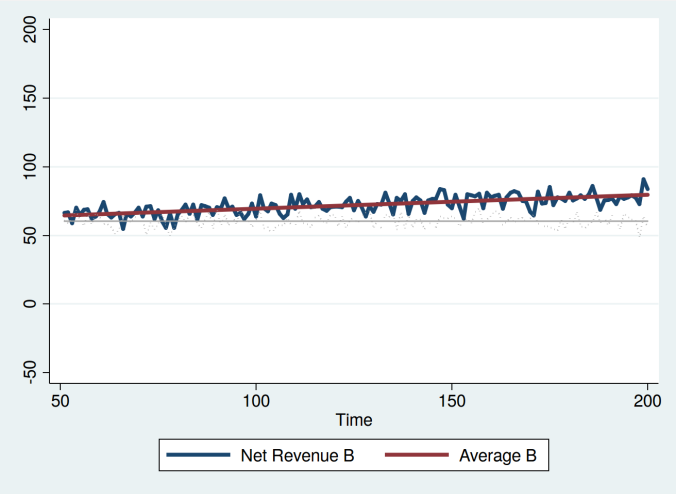


Performance Metric: “Stability”

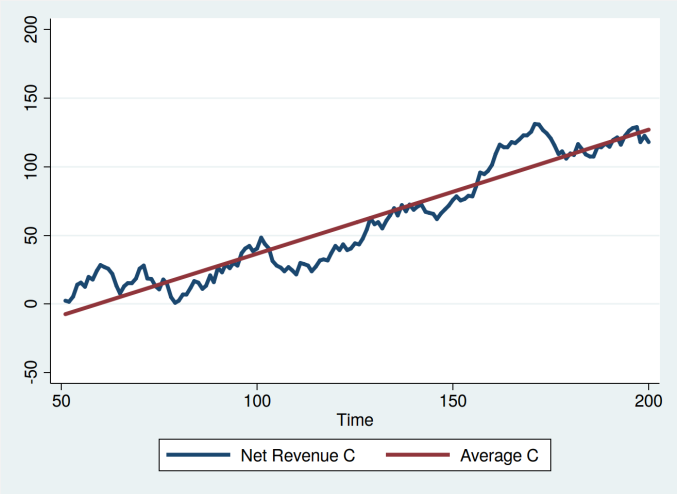


- For each simulation, we can statistically test which of these we have
- For each operating model (8x) and control rule (1,360), how many trials (out of 100) are “stable”? How many are “streaky”?

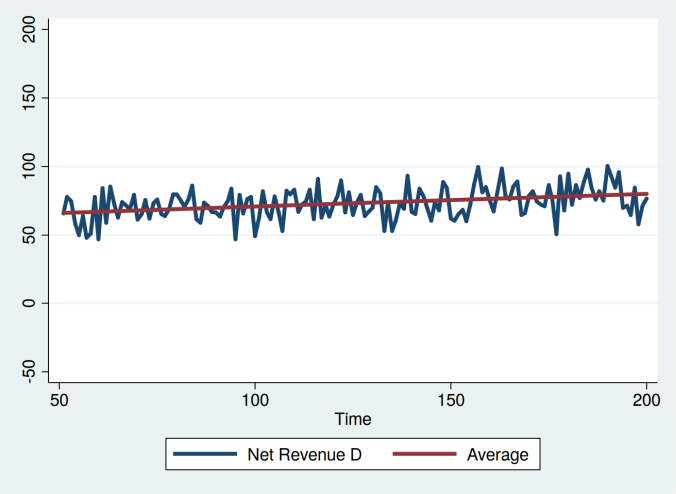
Streaky-ness and IAV are different



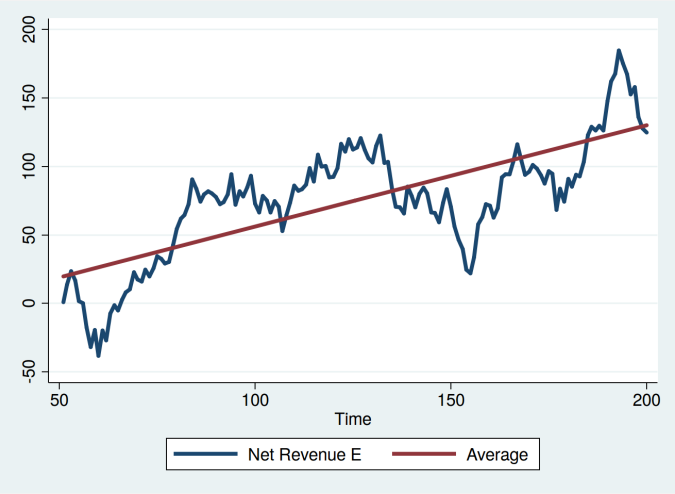
(a) Low IAV, Stable



(b) Low IAV, Streaky



(c) High IAV, Stable



(d) High IAV, Streaky

On discounting and dynamics

- No discounting – comparing the last 50 years of all simulations.
- May need discount when we analyze the costs/benefits of adopting an ABC control rule. Hard to apply to non-dollar things.

References

Brown, G., B. Berger, and M. Ikiara. 2005. “A predator-prey model with an application to Lake Victoria fisheries.” *Marine Resource Economics* 20:221–247.

Dickey, D.A., and W.A. Fuller. 1979. “Distribution of the estimators for autoregressive time series with a unit root.” *Journal of the American statistical association* 74:427–431.

Flaaten, O., and K. Stollery. 1996. “The economic costs of biological predation.” *Environmental and Resource Economics* 8:75–95.