The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

The impacts of federal antimicrobial guidance on the livestock industry

Matthew J. MacLachlan—USDA - Economic Research Service
Christina Letsou—Boston University

INTRODUCTION

- Livestock producers have used antibiotics to:
  - Treat disease (therapeutic use);
  - Prevent and control disease (nontherapeutic or prophylactic/metaphylactic use); and
  - Promote growth through medicated feeds (subtherapeutic use).
- Guidance for Industry 209 and 213 (GFI 209 and 213) limits the use of medically important antimicrobial products in livestock production (FDA, 2013 and 2017).
  - Some products are no longer used while others should only be applied under the supervision of a veterinarian.
  - Potential benefit: reduces selective pressure for antimicrobial resistance on bacteria (antimicrobial stewardship)
  - Potential costs: reduces profitability of livestock producers and pharmaceutical companies and leads to costly adjustments in livestock production
- Changes in antimicrobial use were voluntary and phased in slowly
  - GFI 209 was released in April, 2012 and GFI was fully implemented by 2017.
  - Antimicrobial use decreased dramatically between 2015 and 2017.
- The ambiguous timing of changes in the market complicate measurement of aggregate impacts on producers, processors, and pharmaceutical companies.

RESEARCH OBJECTIVES

- To establish an approach for detecting and estimating the changes in livestock profit and production indicators between 2000 and 2019; and
- Compare the timing of structural breaks with changes in FDA's Guidance for Industry and other events that affected livestock production and markets.

MODEL AND ESTIMATION

- We estimate the parameters of a seasonal autoregressive moving average model with trends and breaks (SARMAX).
- Differencing may fit the data better, but obscure changes in levels.
- Our general model includes all possible included terms:

$$\left(1 - \sum_{i=1}^{p} \alpha_i L^i\right)\left(\sum_{j=1}^{P} 1 + A_j L^{j*12}\right) y_t$$
$$= c + \left(\sum_{i=1}^{q} 1 + \theta_i L^i\right)\left(\sum_{j=1}^{Q} 1 + \Theta_j L^{j*12}\right)\varepsilon_t + \delta_t + \omega t + \mathbf{1}(t > \tau)(\eta + \gamma t).$$

  - p & P: number of autoregressive (AR) and seasonal AR lags
  - α & A: AR and seasonal AR parameters
  - L: lag operator
  - q & Q: number of moving average (MA) and season MA lags
  - θ & Θ: MA and seasonal MA parameters
  - δ & ω: monthly fixed effects and linear trend
  - τ: date of structural break
  - η & γ: structural break/drift and trend break

- Each model is evaluated using its Akaike Information Criterion with a small sample adjustment (AICc). The model with the smallest AICc is defined as optimal. Models with slightly greater (worse) AICc scores must also be considered which imply remaining specification uncertainty.

$$AICc = \underbrace{2\text{negative log likelihood}}_{\text{goodness of fit}} + 2k + \underbrace{\frac{2k^2 + 2k}{n - k - 1}}_{\substack{\text{penalty for} \\ \text{parameters}}}$$

  - k: number of parameters
  - n: number of observations

LIVESTOCK PRODUCTION INDICATORS

Data were drawn from the National Agricultural Statistics Survey's Quickstats portal. We check for a structural change in the inventories, production, and dressed weights of beef cattle, hogs, and broiler chickens.

Beef cattle

- Inventories declined sharply during and following the widespread drought in 2012–2013.
- Declines in inventory were followed by marked reductions in production volumes as cattle operations rebuilt their herds.
- Weights have been steadily increasing during the period of observation, with a slight flattening near the end of the series.
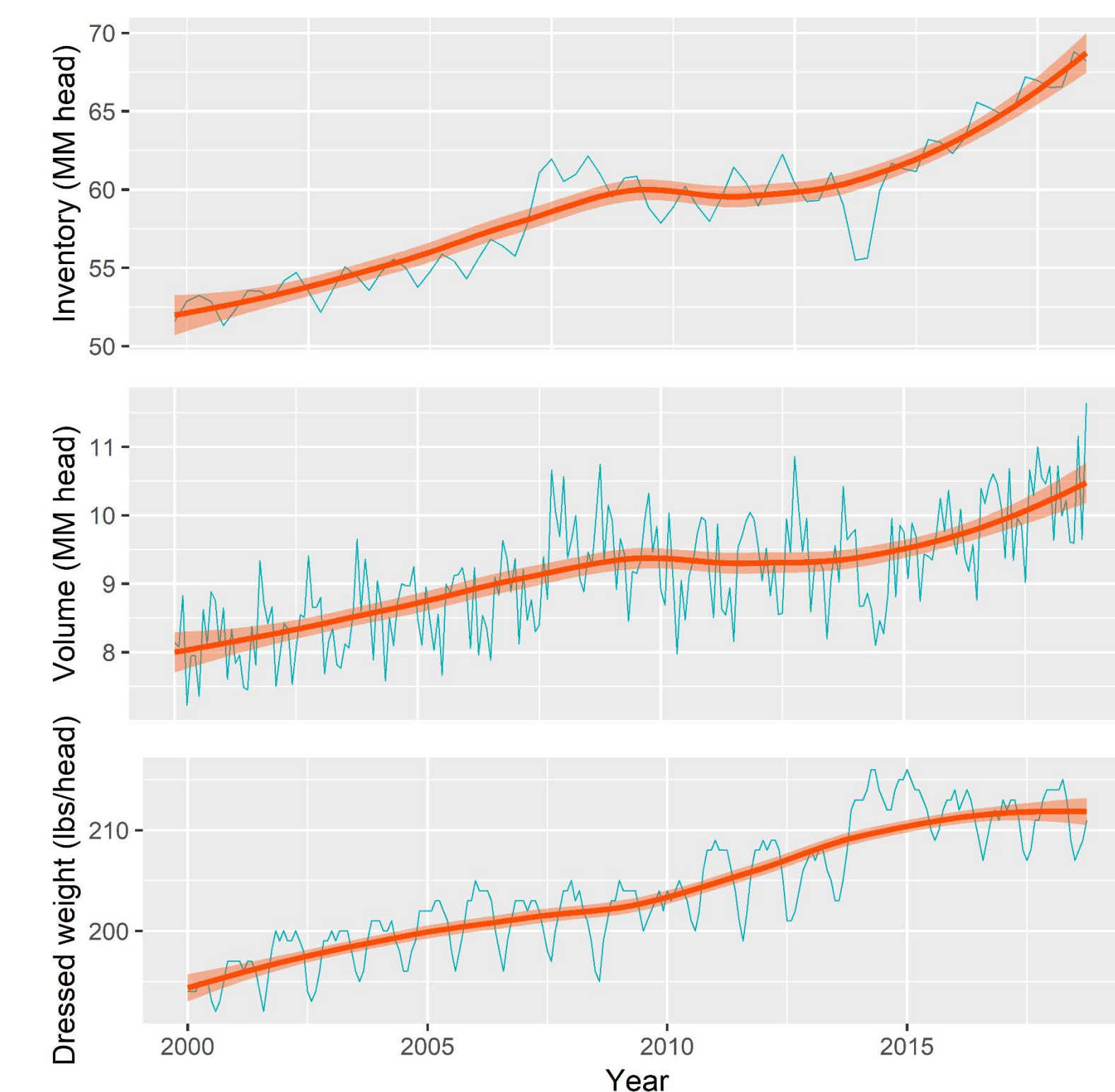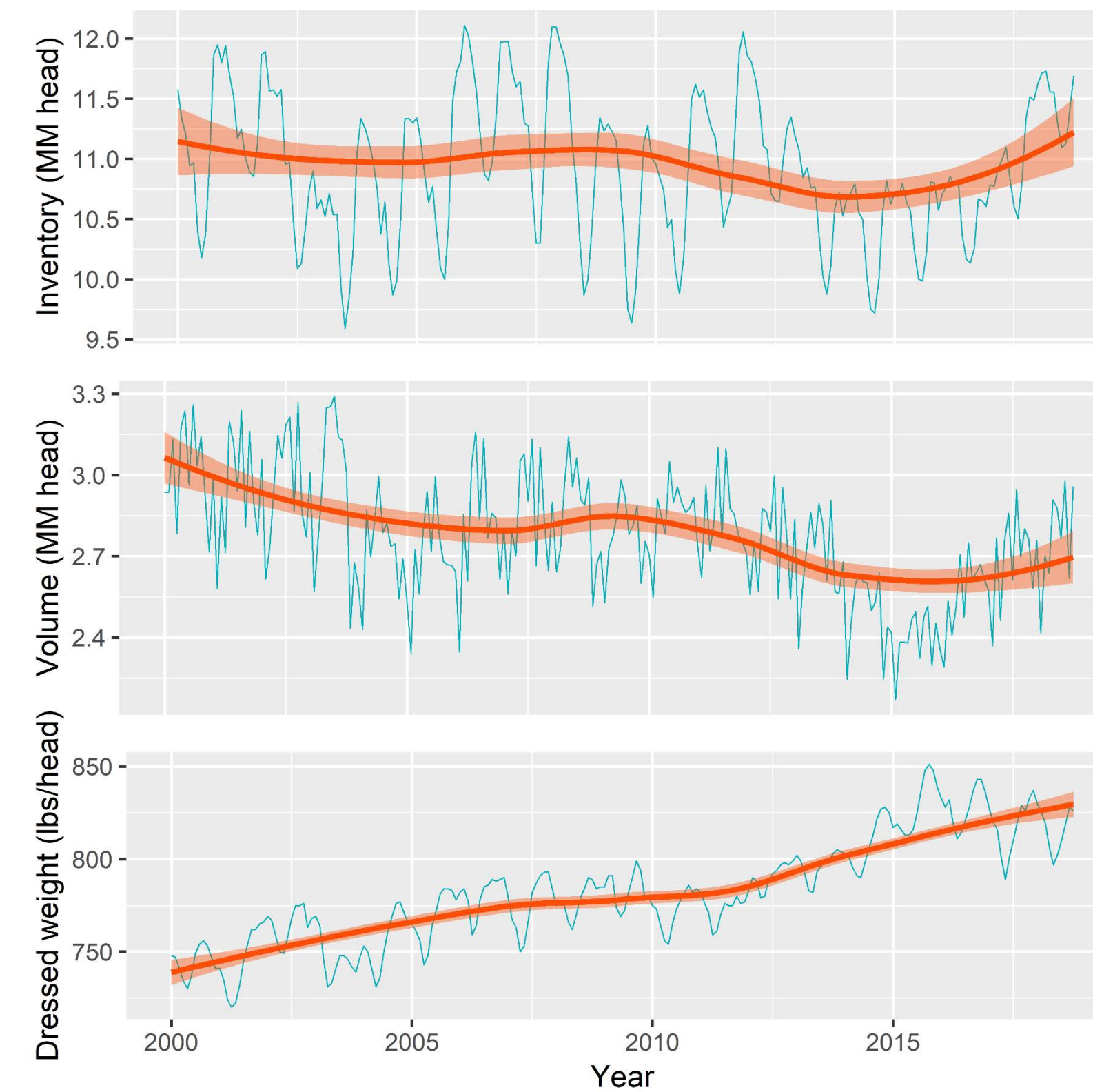

Hogs

- Since the initiation of GFI 213, hog inventories largely increased while the dressed weight of hogs has increased and flattened slightly.
- The volume of hog production leveled off following the 2008 financial crises and has increased at a slightly faster rate since 2012.

Broiler chickens

- The volume of broiler meat produced declined following the financial collapse in 2008, but has steadily increased since 2010.
- Weights have steadily increased with only a small detectable upward shift in 2012.

GFI 213 Implementation

GFI 209
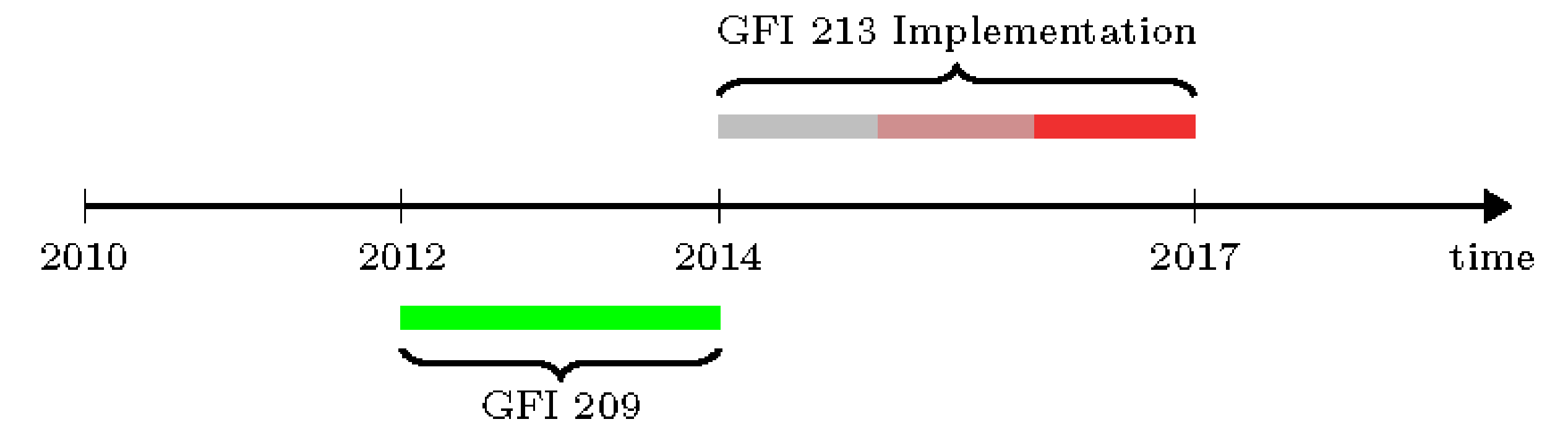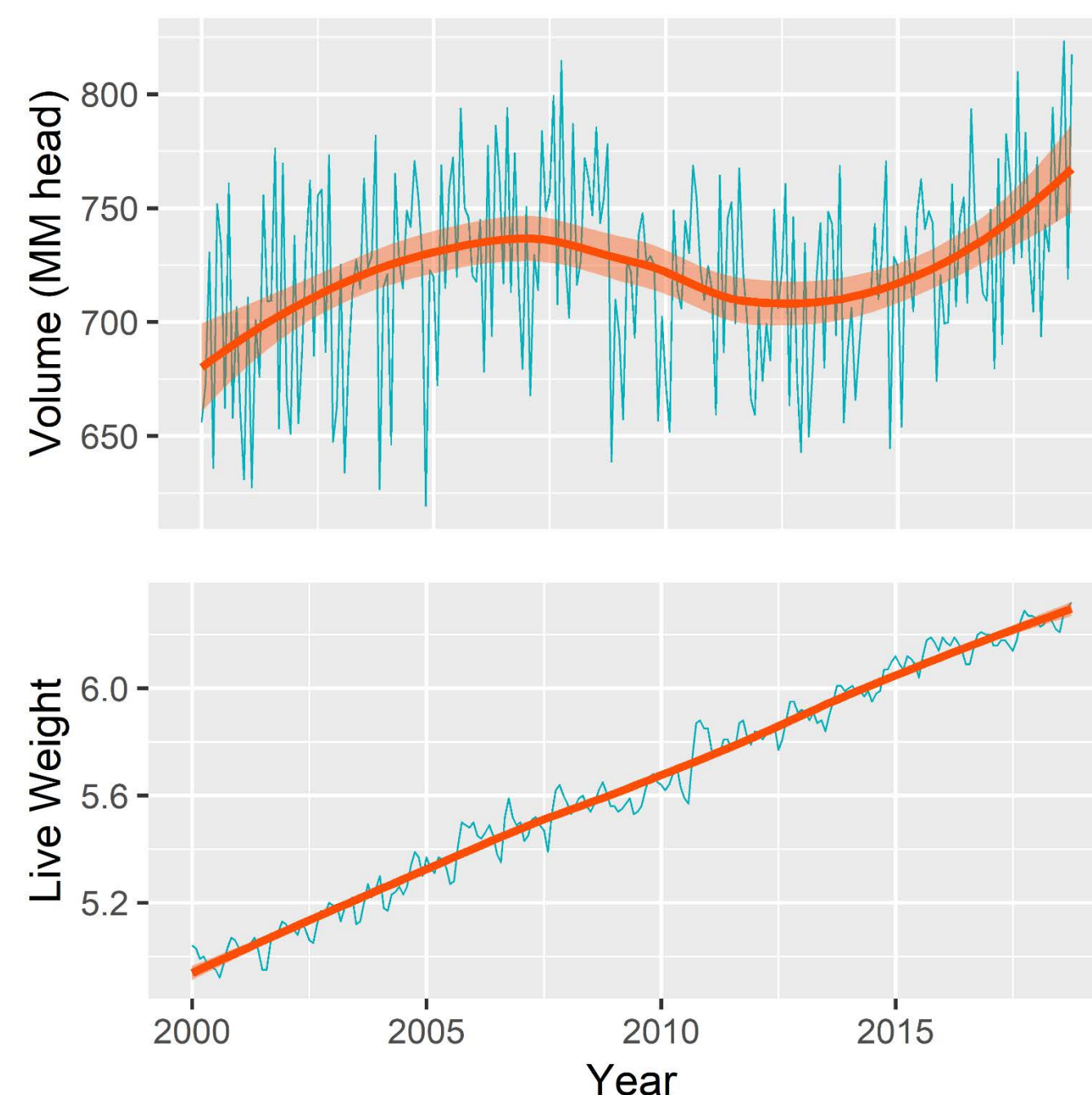
RESULTS

Key findings

Commodity production responded to other larger events

- The model detects a decline in beef cattle inventory beginning in 2010. This decline coincides with an historic drought. Volume and weight changes may be linked to a recovery of this industry or could indicate mild production responses to antimicrobial use.
- The 2008 financial crises led to changes in broiler production.
- Hog producers may have made slight adjustments to inventories following the implementation of GFI 213.

	Beef cattle			Hogs			Broiler chickens	
	Inventory	Volume	Weight	Inventory	Volume	Weight	Volume	Weight
Break date	Oct '10	May '15	Mar '16	Q1 '14	Dec '12	Nov '13	Nov '08	Sep '10
Type	Break	Break/ trend	Break/ trend	Break/ trend	Break/ trend	Break/ trend	Break/ Trend	Break
St break parameter	-285 (111)	-154 (68.8)	11.3 (3.68)	-1,872 (556)	-0.68 (0.17)	3.17	-55,444 (5621)	0.066 (0.021)
St trend parameter	-	6.57 (3.43)	-0.70 (0.43)	371 (79)	0.0076 (0.0038)	-0.07 (0.03)	-328 (76)	-
ARIMA model	(2,0,0) x (0,0,1)	(3,0,1) x (4,0,2)	(1,0,1) x (0,0,1)	(2,0,2) x (1,0,0)	(1,0,5) x (3,0,1)	(1,0,0) x (0,0,0)	(0,0,3) x (3,0,1)	(1,0,0) x (1,0,0)
Intercept	Y	Y	Y	Y	N	Y	Y	Y
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Trend	N	Y	Y	Y	Y	Y	Y	Y
N	226	226	226	125	226	226	226	226

CONCLUSIONS

- The rapid decline in the use of antibiotics observed in 2017 and 2018 by Sneeringer, Bowman, and Clancy (2019) did not coincide with large changes in livestock production indicators considered in this research.
  - Changes in environmental and macroeconomic conditions, which preceded GFI implementation, likely caused most of the breaks detected in our analysis.
- The gradual implementation of GFIs may have led to gradual changes in production, which would encumber the detection of these changes.

REFERENCES

- Sneeringer, S., Bowman, M., and M. Clancy 2019. "The U.S. and EU Animal Pharmaceutical Industries in the Age of Antibiotic Resistance." *USDA Economic Research Report*. Forthcoming.
- Food and Drug Administration (FDA). 2017. "FDA Announces Implementation of GFI #213, Outlines Continuing Efforts to Address Antimicrobial Resistance." Working paper, Food and Drug Administration, Center for Veterinary Medicine.
- FDA. 2013. "Guidance for Industry #213: New Animal Drugs and New Animal Drug Combination Products Administered in or on Medicated Feed or Drinking Water of Food-Producing Animals: Recommendations for Drug Sponsors for Voluntarily Aligning Product Use Conditions with GFI #209." Working paper, Food and Drug Administration, Center for Veterinary Medicine.