

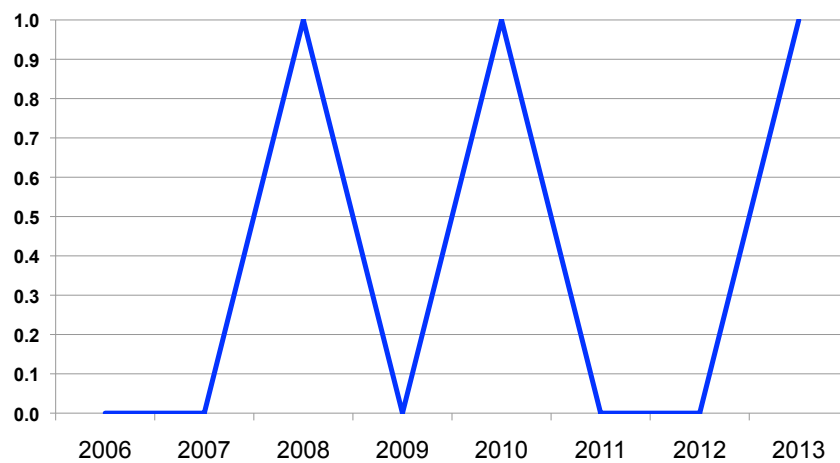
# Long Live the Three-Year US Milk Price Cycle?

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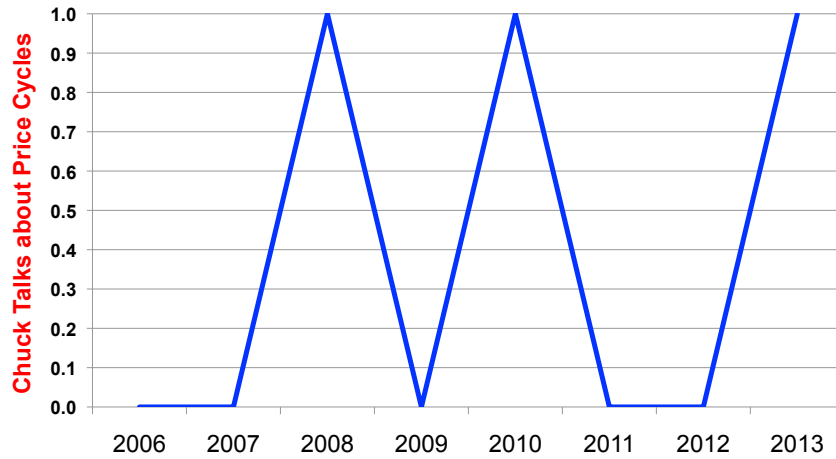


## The Cycle



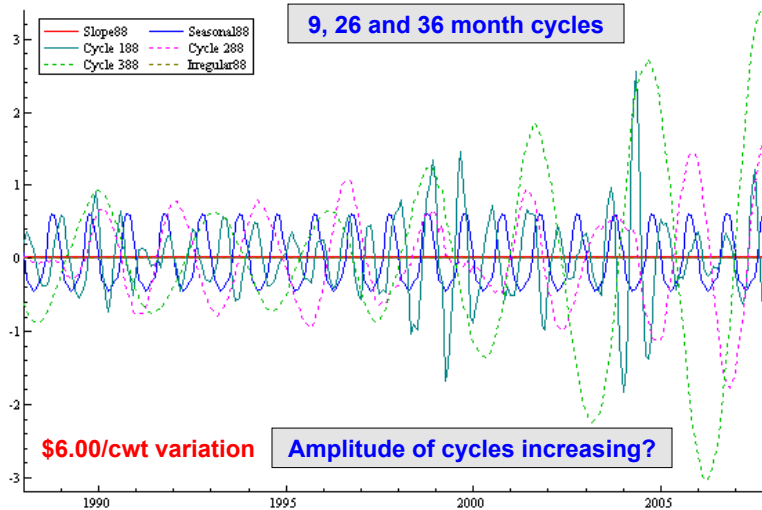
**Average frequency 2006 – 2013: every 2.7 years**

# The Cycle

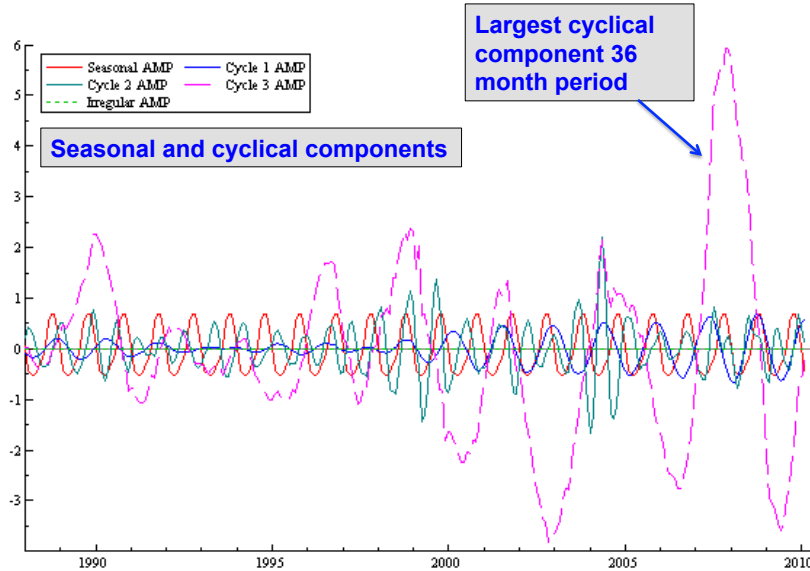


Average frequency 2006 – 2013: every 2.7 years

# All-Milk Price Cycles (2008)



## All-Milk Price Cycles (2010)



## Other Cycles (2010)

Variable	Range of Level Effect	Amplitude of Seasonal Effect	Largest Amplitude Cycle	Amplitude of Largest Cycle
All-Milk Price	\$3.00/cwt	\$1.00/cwt	<b>36-month</b>	<b>\$9.00/cwt</b>
Daily Milk Production	235 mil lbs	40 mil lbs	<b>34-month</b>	10 mil lbs
Milk-Feed Price	1.2	0.5	<b>33-month</b>	<b>1.0</b>
Cheese Price	\$0.30/lb	\$0.20/cwt	<b>36-month</b>	<b>\$0.80/lb</b>
Whey Price*	\$0.50/lb	\$0.05/lb	<b>34-month</b>	\$0.09/lb
Class III Price	\$4.00/cwt	\$1.60/cwt	<b>37-month</b>	<b>\$8.00/cwt</b>
NDM Price	\$0.65	\$0.10/lb	<b>34-month</b>	<b>\$0.70/cwt</b>
Butter Price	\$0.75	\$0.20/lb	<b>36-month</b>	<b>\$0.70/lb</b>
Class IV	\$4.00/cwt	\$2.00/cwt	<b>34-month</b>	<b>\$8.50/cwt</b>

\*Since 2000

**Indicates cyclical component large relative to range and(or) seasonal**  
**Rough convergence of periods of largest cycles**

## What's New?

### Context is now different:

- Rabobank says “the cycle is dead” due to trade linkages
  - [Dysrhythmia \(October 2012\)](#)
- Did the 2009 shock “re-set” or eliminate the cycles?
- World of higher feed prices and new business models

## This I Believe...About Milk Price Cycles

Which represents your view?

- A. They never existed / evidence not sufficient
- B. They existed but now they are dead
- C. They existed but I'm not sure what the future holds
- D. They existed and probably will in the future

## Today's Questions

- What does updated statistical analysis indicate about the cycle?
- What causes cycles?
  - Caused, if dead
- If the (a) cycle is still with us, what are the implications?

## Methods

- State-space (decomposition) statistical analysis of All-milk price
  - Level (average)
  - Slope (trend)
  - Seasonal (within year cycle)
  - Cycle
- Controls for effect of feed cost
  - Also tested for effects of trade value/volume

## Methods

- Quarterly data 1996(2) to 2012(1)
  - 17 years, post-URA
  - All-milk price and NASS 16% protein ration
- Compare forecast to actual data for 2012(2) to 2013(1)
  - If consistent, suggestive of continued cycle to date

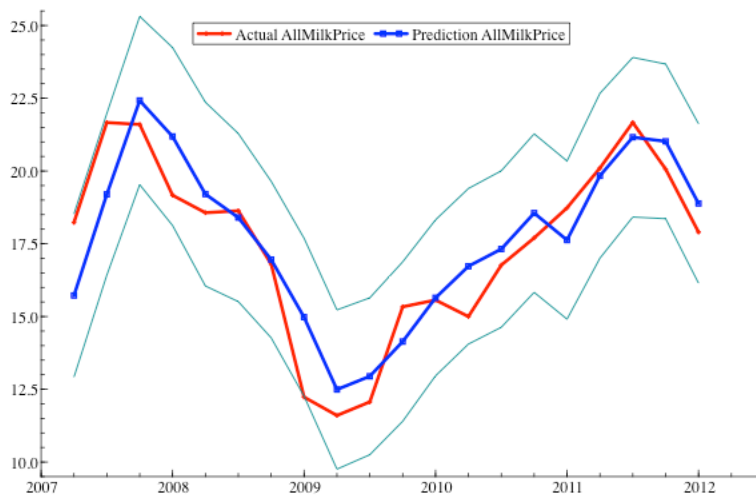
## Key Findings

- Slope, seasonal and cyclical factors important
- Feed contributes \$0.77/cwt for every \$1 change in ration value
- Trade variables have limited impact

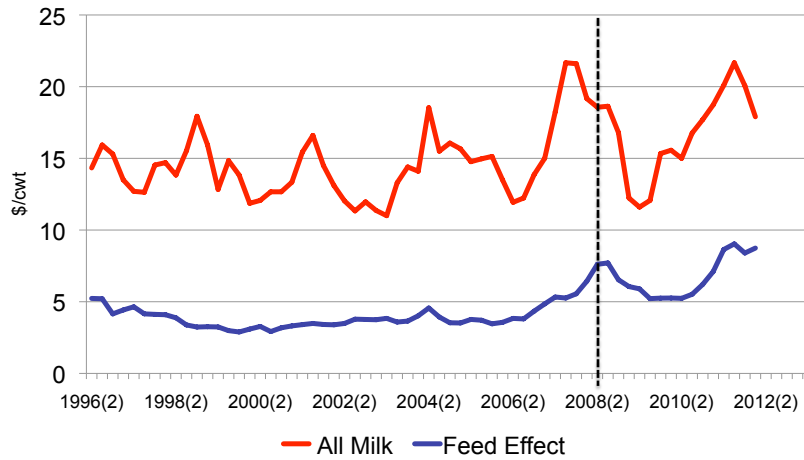
# Model Testing

- Model passes all the usual statistical tests on errors (residuals)
  - Normal, not serially correlated, homoskedastic

## Predicted versus Actual 2007-2012

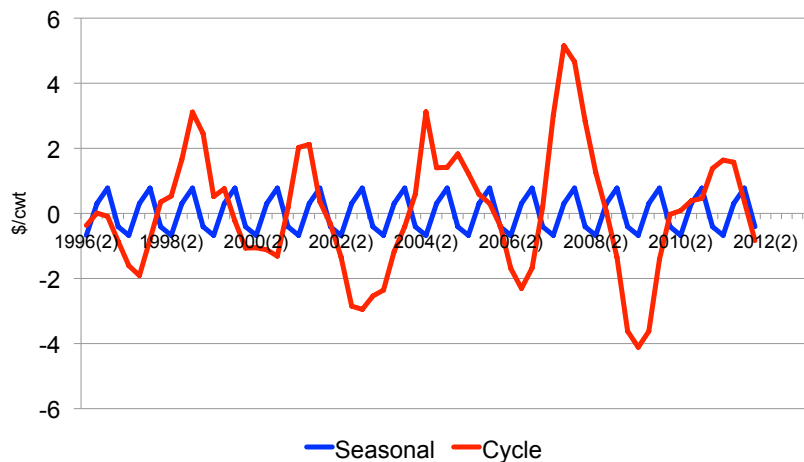


## All-Milk and Feed Impact



Feed has an impact on prices, but not on existence or timing of cycles

## Seasonal and Cyclical Effects



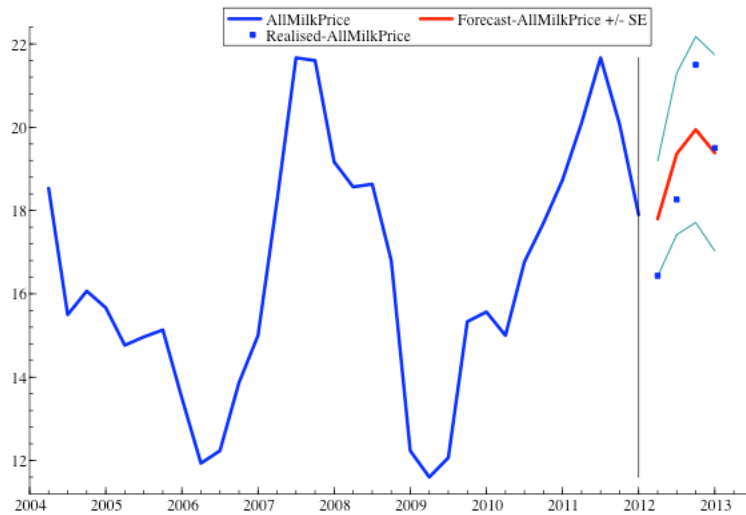
Cyclical pattern exists through 2012, but peak of recent cycle lower



## Cycle Findings

- Cycle length = 3.2 years
  - 38 months
- Recent amplitude estimate = \$1.50/cwt
  - Less than previous cycle

## Ex Post Forecast

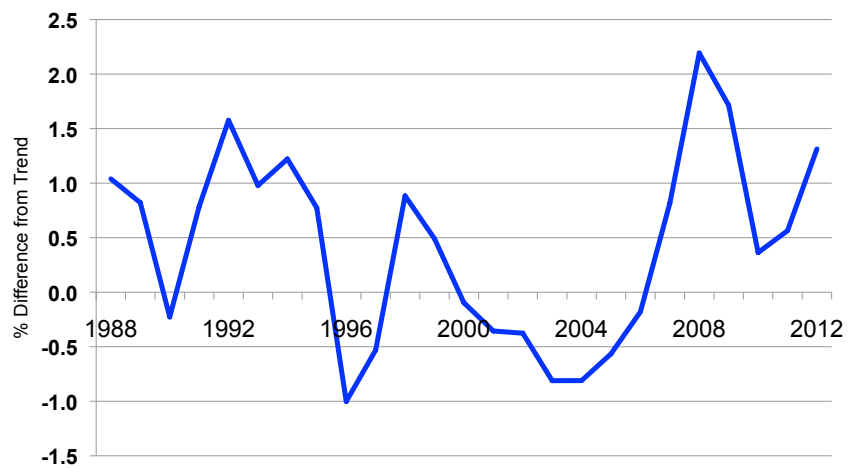


Observations for 2012(2) to 2013(1) broadly consistent with model forecast

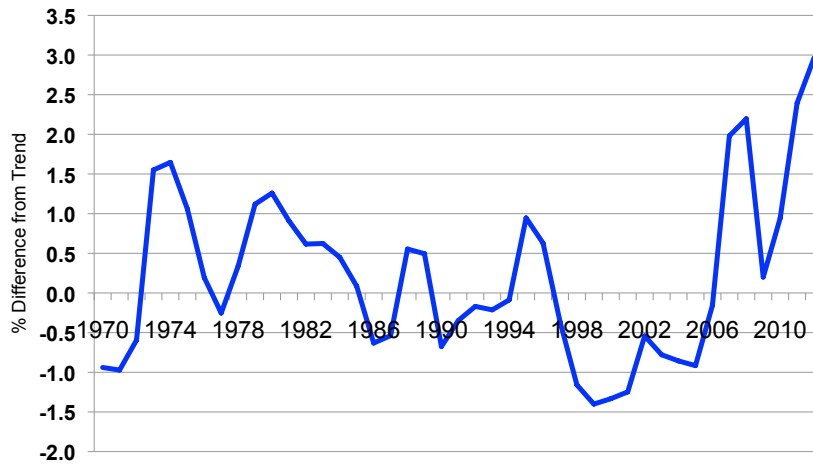
## Price & Production Cycles Are Very Common

- Agricultural commodities
- Other commodities
- Housing
- GDP

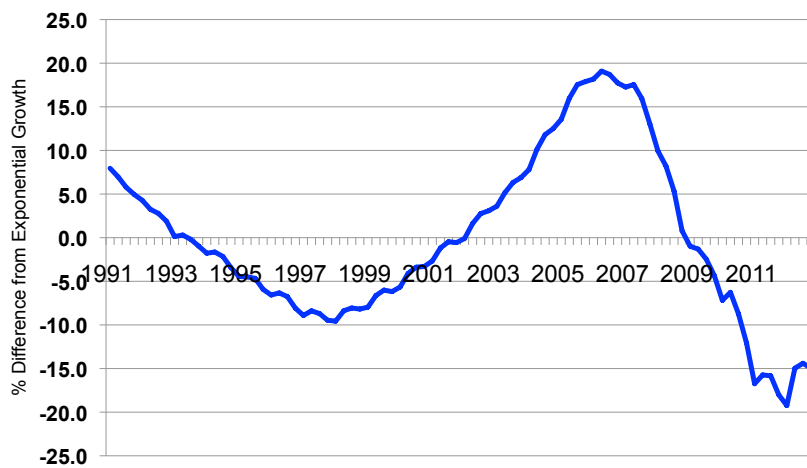
## Hog Production Cycle



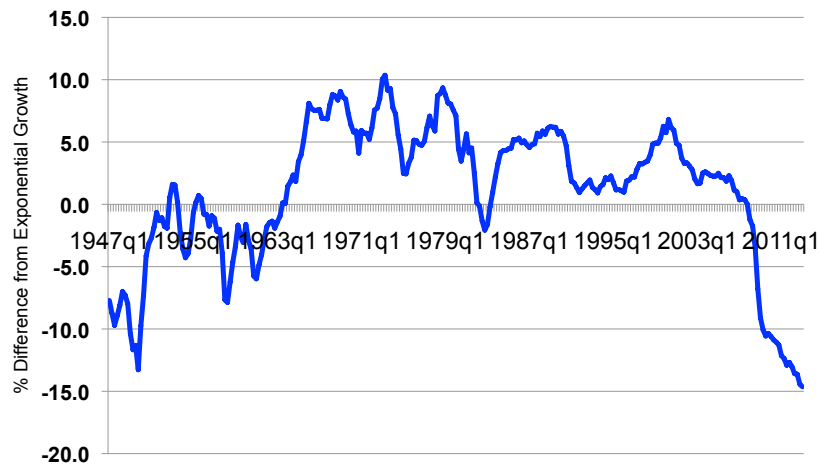
## Wheat Price Cycle



## Housing Price Cycle



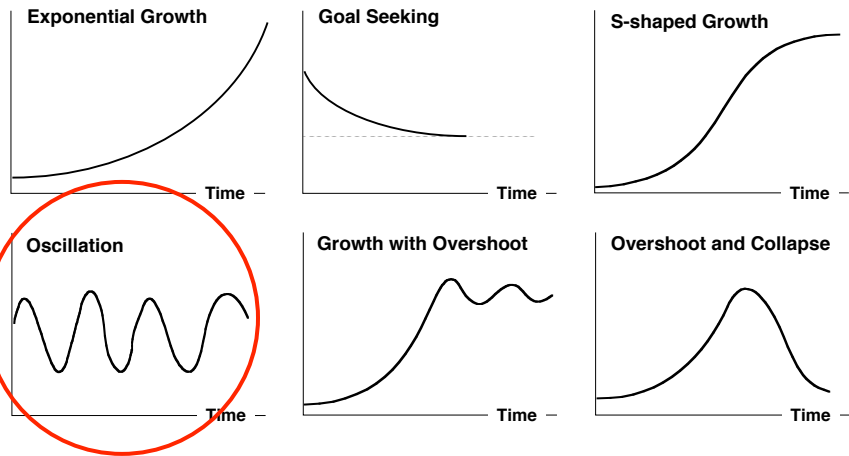
## GDP Cycle



## What's in Common?

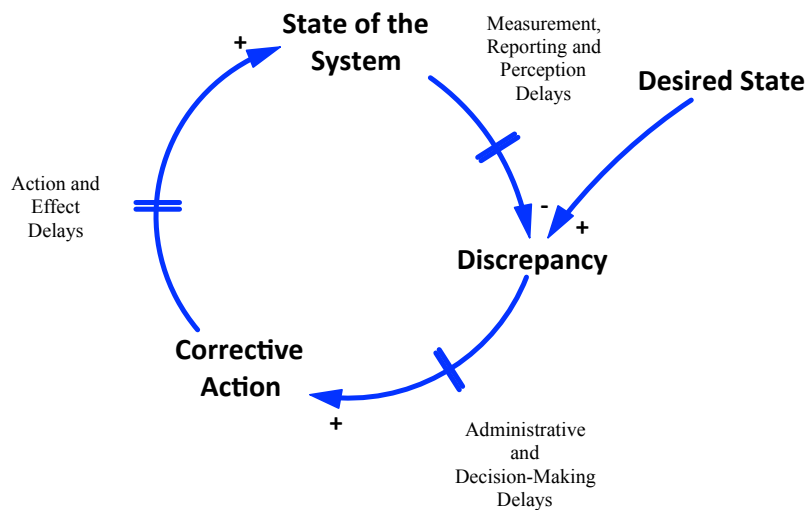
- Oscillations
- What causes oscillations?
- In systems speak:
- “Negative feedback loops with a delay”
  - System structure causes behavior
  - This is the ONLY “system structure” that creates oscillatory behavior

# Common Modes of Behavior



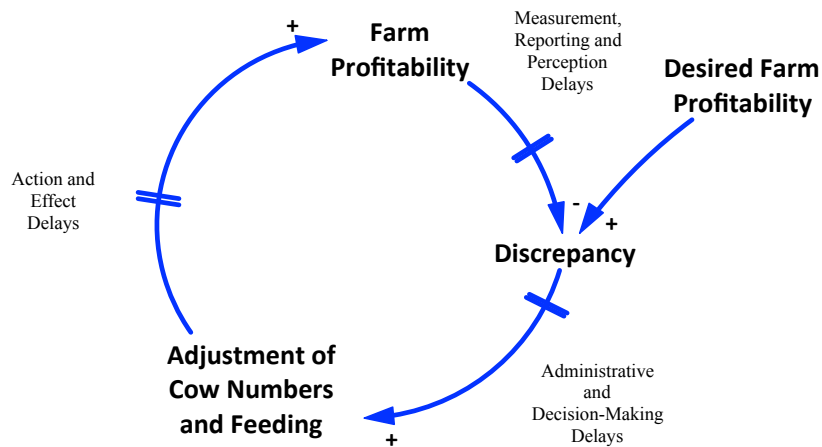
Oscillation is a very common behavior—it is caused by an underlying structure

# Structure for Oscillations



# Structure for Milk Price Oscillations

(One structure among many possible ones)



## In Supply Chain Speak...

- Instability is common in supply chains
- Often the result of individual businesses responding rationally to incentives
- But with delays and without sufficient coordination

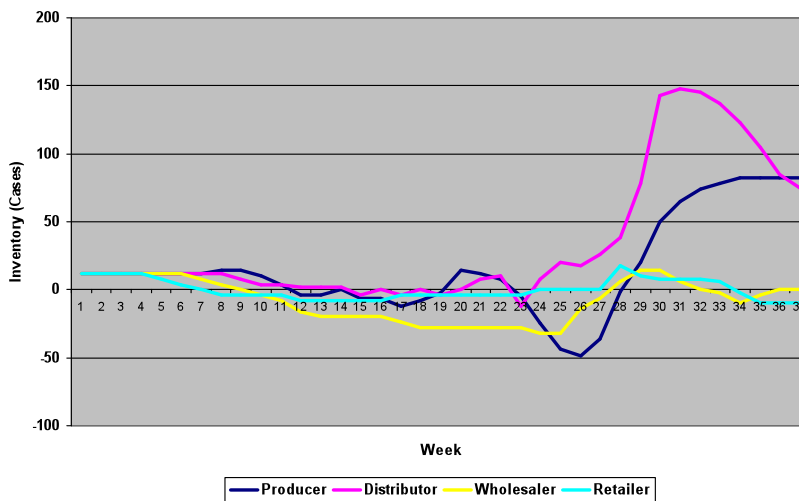
# Have You Played “The Beer Game”?

- Game played to simulate supply chain ordering decisions
- Often used with groups of top executives
- Usually results in instability--oscillations



## Inventory Amounts Vary a Lot!

Los Borrachos Inventories



Actual results from The Beer Game with Executives

## This Instability is Called the “Bullwhip Effect”



Orders vary and often amplified  
as they move upstream in the  
supply chain

## Why Cycles?

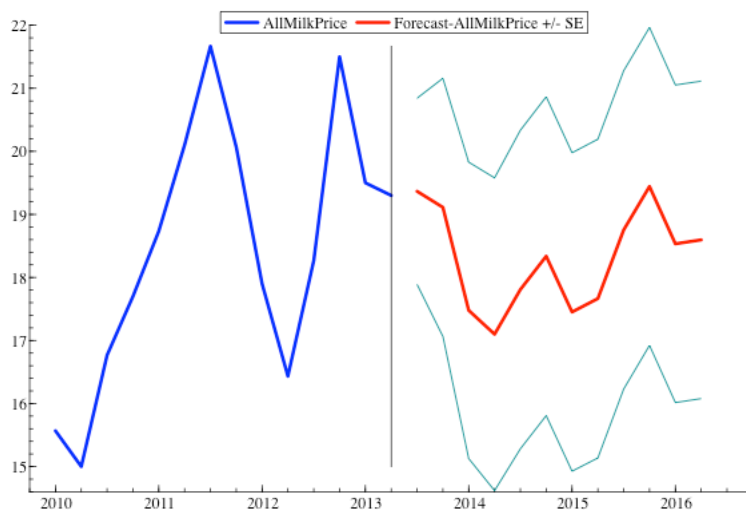
- Interaction of physical **delays** in production and capacity adjustment with **boundedly rational decision making** by individual producers and investors
- Persistence of cycles suggests that **learning and market forces** that might stabilize cycles are weak



## What Do Models Suggest About Future Cycles?

- Forecasting three years ahead with State-space model
  - Model ignoring feed prices (so don't have to forecast these)

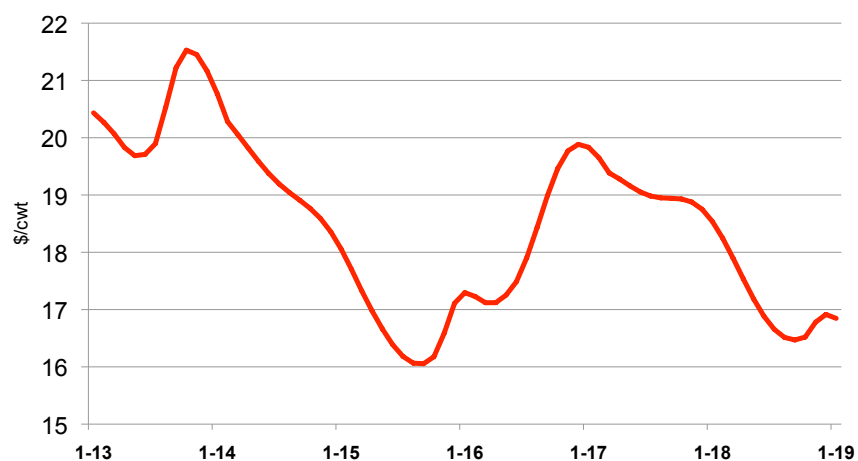
## SSM Suggests Continued Dampened Cycles



## What Do Models Suggest About Future Cycles?

- We also modified our structural dynamic model
  - Updated to 2011 base data
  - Incorporates these supply chain effects
- Suggests continued cyclical behavior
  - Although dampened by assumed lower feed price values based on USDA forecast

### Dynamic Model Projections



Somewhat larger amplitude (SSM uses a dampening factor)

## The Bottom Line

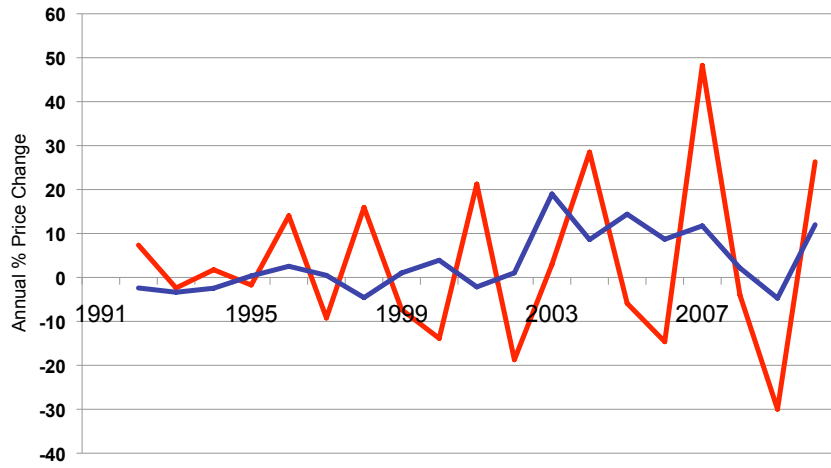
- There is evidence that cycles are not dead
  - But they may be dampened in the future?
- Cycles arise from rational decisions by supply chain actors
  - Especially on the supply side?
- If cycles exist, forecasts and policy analyses should account for them

## The King is Dead...

- Long live the King!



## Must These Cycles Exist in Dairy?



Price change behavior differs for different countries—one much more cyclical