Price Volatility in US Dairy Markets

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What Are the Challenges and Issues with Respect to Price (or Margins)?

Three Very Different Characteristics of Price

Uncertainty/Certainty (or predictability) - good, bad or otherwise, to what degree can I predict what the price will be?

Instability/Stability - good, bad or otherwise, prices do/don't change much from one month to the next

- Perfectly stable implies certainty, but certainty does not imply stable

Inadequacy/Adequacy - stable or not, prices are enough to cover my costs and yield a profit

Some Basic Questions about Price Volatility

- Does it exist?
- How much is it?
- Is it a problem?
- In what way is it a problem?
- For whom is it a problem?
- What can be done about it?
  - To treat the symptoms or to treat the cause
  - Public solutions vs private solutions
  - Existing tools or new tools?

Summary of Industry Opinions

Volatility is an important issue

- Not as big an issue as adequacy (but somewhat inseparable)
- Has become a bigger problem over time and is substantial or unbearable for many

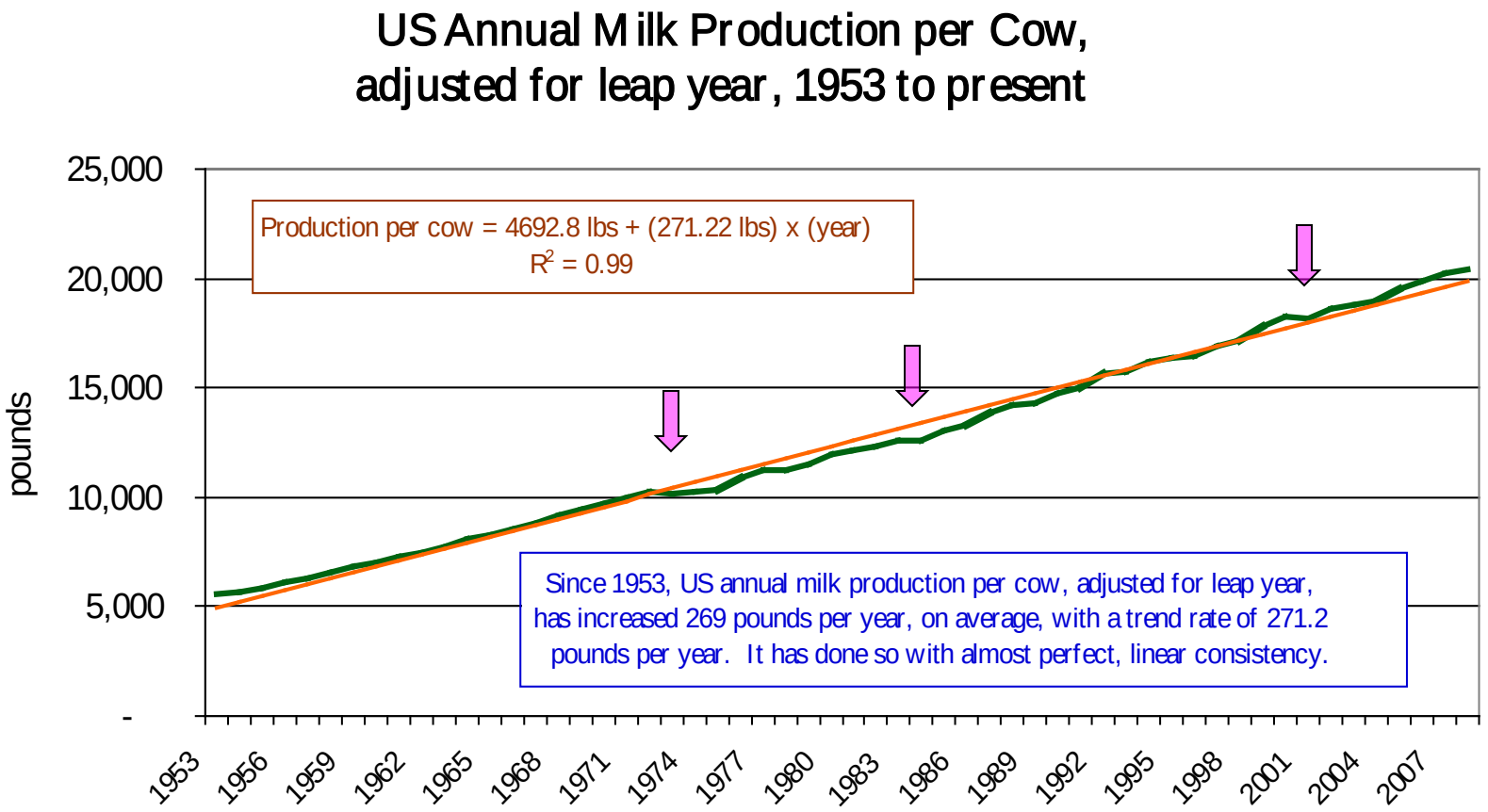
The policy response to volatility?

- Majority say firms should manage their own risk
- 43% say a policy response is appropriate

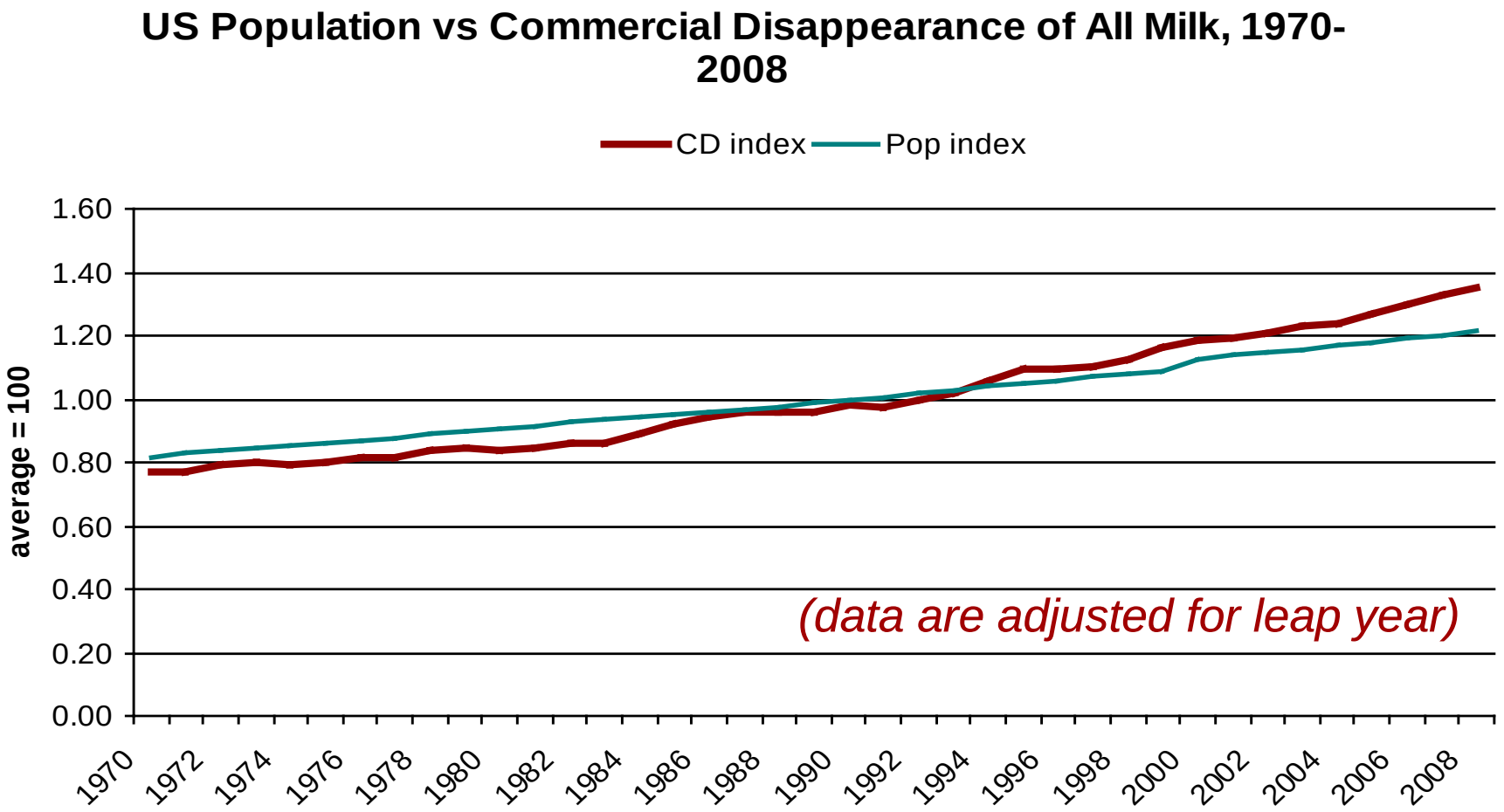
Long Term Trends that Determine the Price of Milk Over Decades

Milk production per cow has shown a persistent and highly linear upward trend over the last 100 years. Prior to 1953, it increased at a trend rate of only 39 lbs/yr. Since then it is 271 lbs/yr.

The downturns of 1973 and 2001 were small and came at a time huge feed price increases relative to milk price, and 1984, which was larger, can be attributed to the Milk Diversion Program. The year to year change has been a bit more erratic since the mid-1970s.



Commercial Disappearance of milk closely parallels population growth. Per capita is growing slightly too. Exports (foreign demand) will become a more important driver in the future (kind of a new population effect).

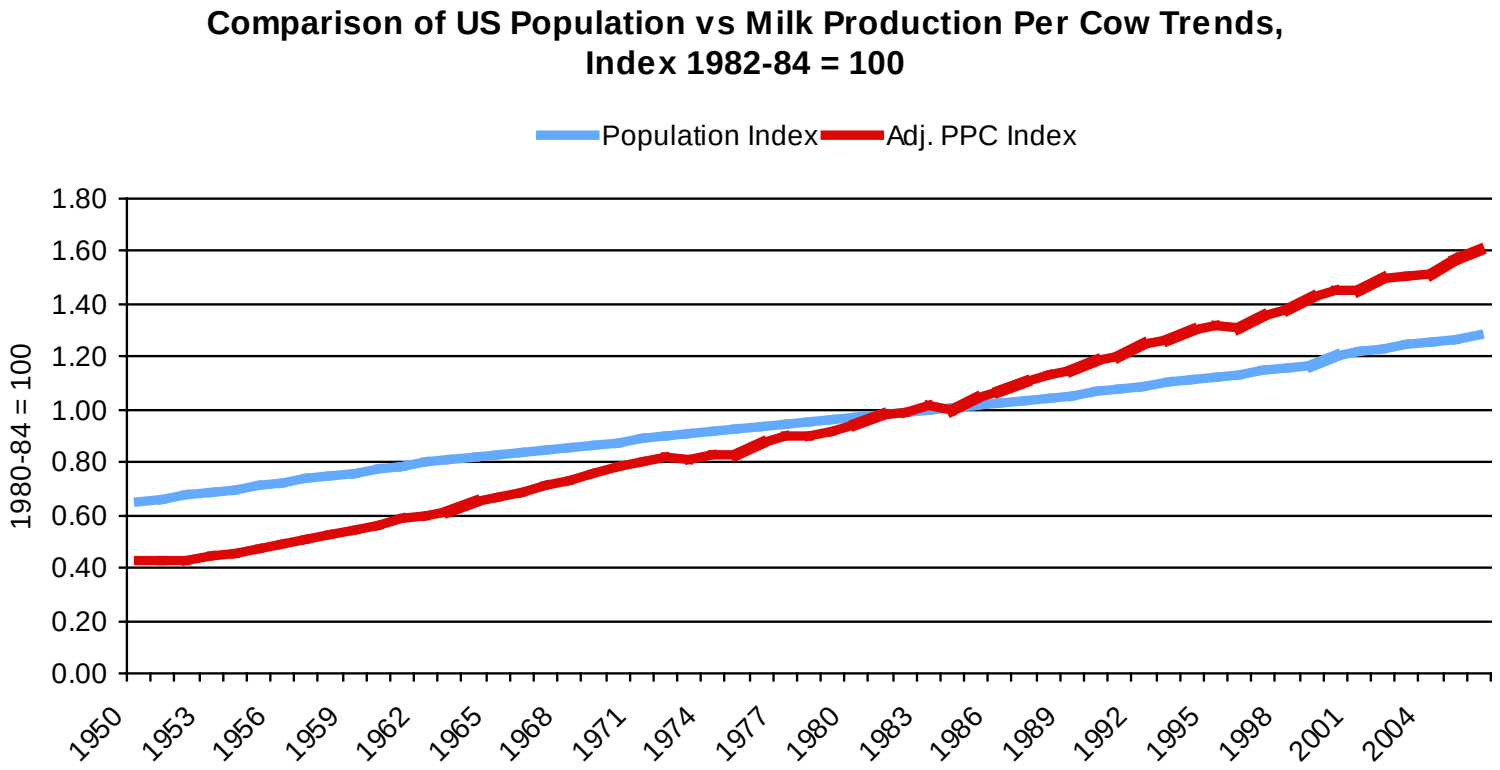


Concluding Comments: Trend

Trend is no longer particularly interesting from a practical standpoint, although it remains economically important

- Milk price trends are driven by linear trends in productivity and population.
- Productivity has grown more quickly than population.
- Thus, farm milk prices increase at a lower rate than inflation or declining “real” farm milk prices

Only when feed prices are very high relative to milk, do farmers make management decisions about yield that are short term. Otherwise, the key decision is “how many cows”



What's Happened to Milk Prices: A shorter run view

Seasons and Cycles

How Big is the Problem?
How to Measure Volatility?

Range - minimum to maximum

- Do we only care about the minimum?

Frequency Distribution or Interquartile Range - measures how prices are distributed in between the top and bottom

Variance or Standard Deviation - measures of dispersion relative to a mean or average

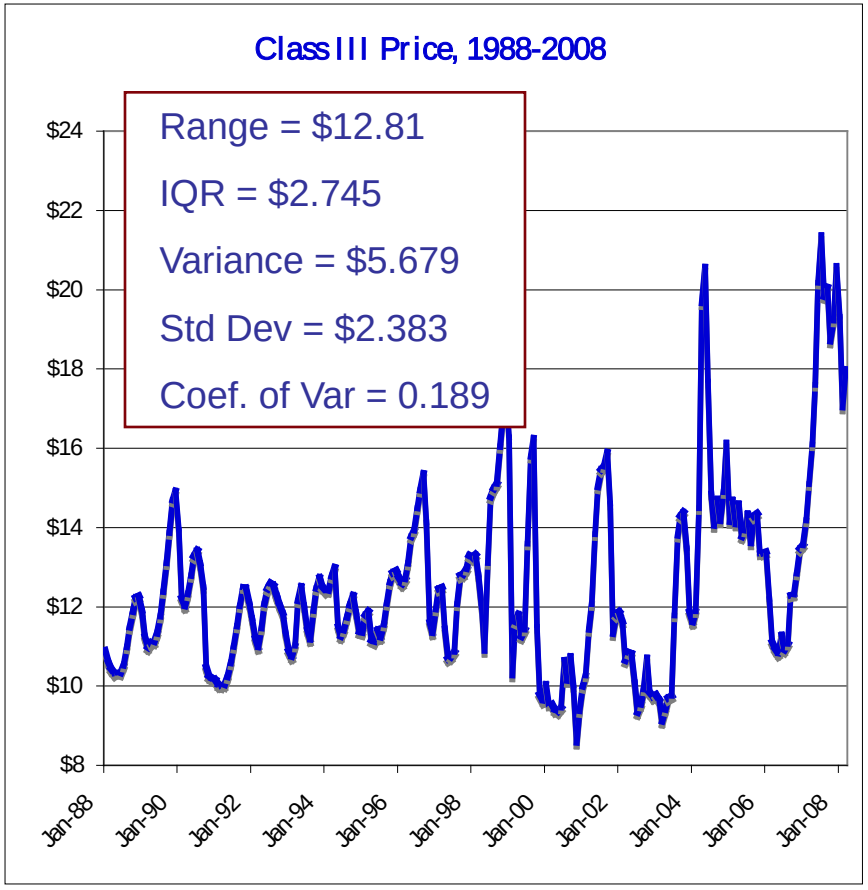
Coefficient of Variation - useful in comparing the deviation of two distributions that have markedly different means

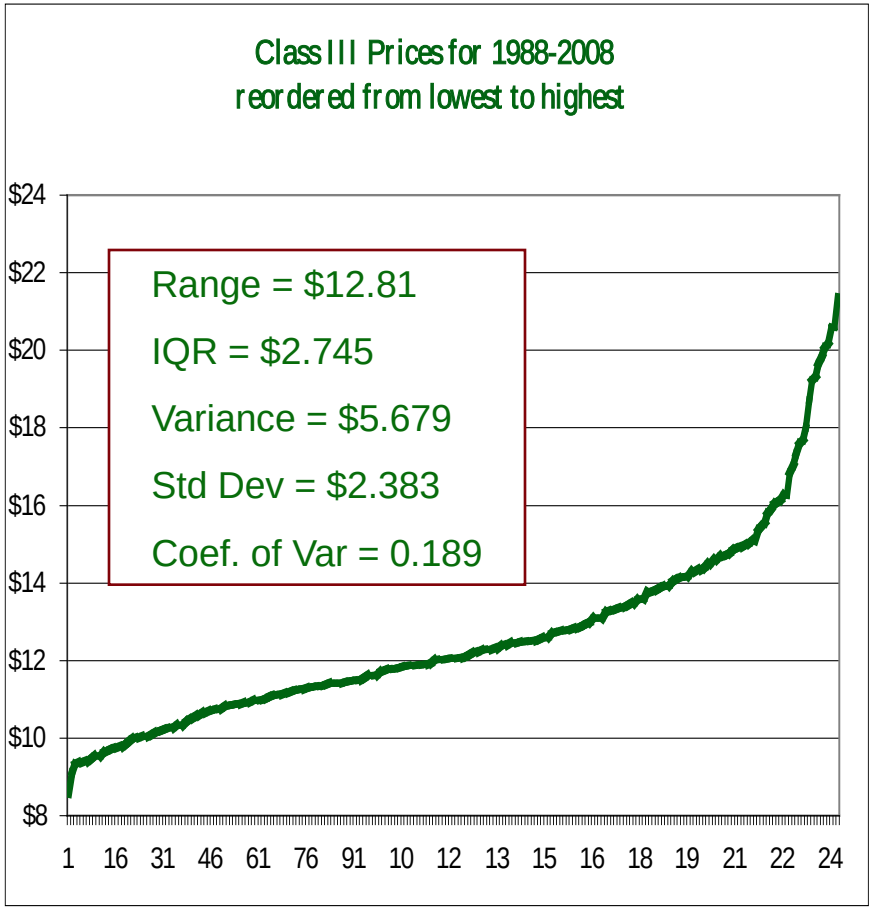
And a number of other more complex measures

Does it matter how we measure volatility?

Don't all measures indicate the same thing, more or less?

Which is More Variable?





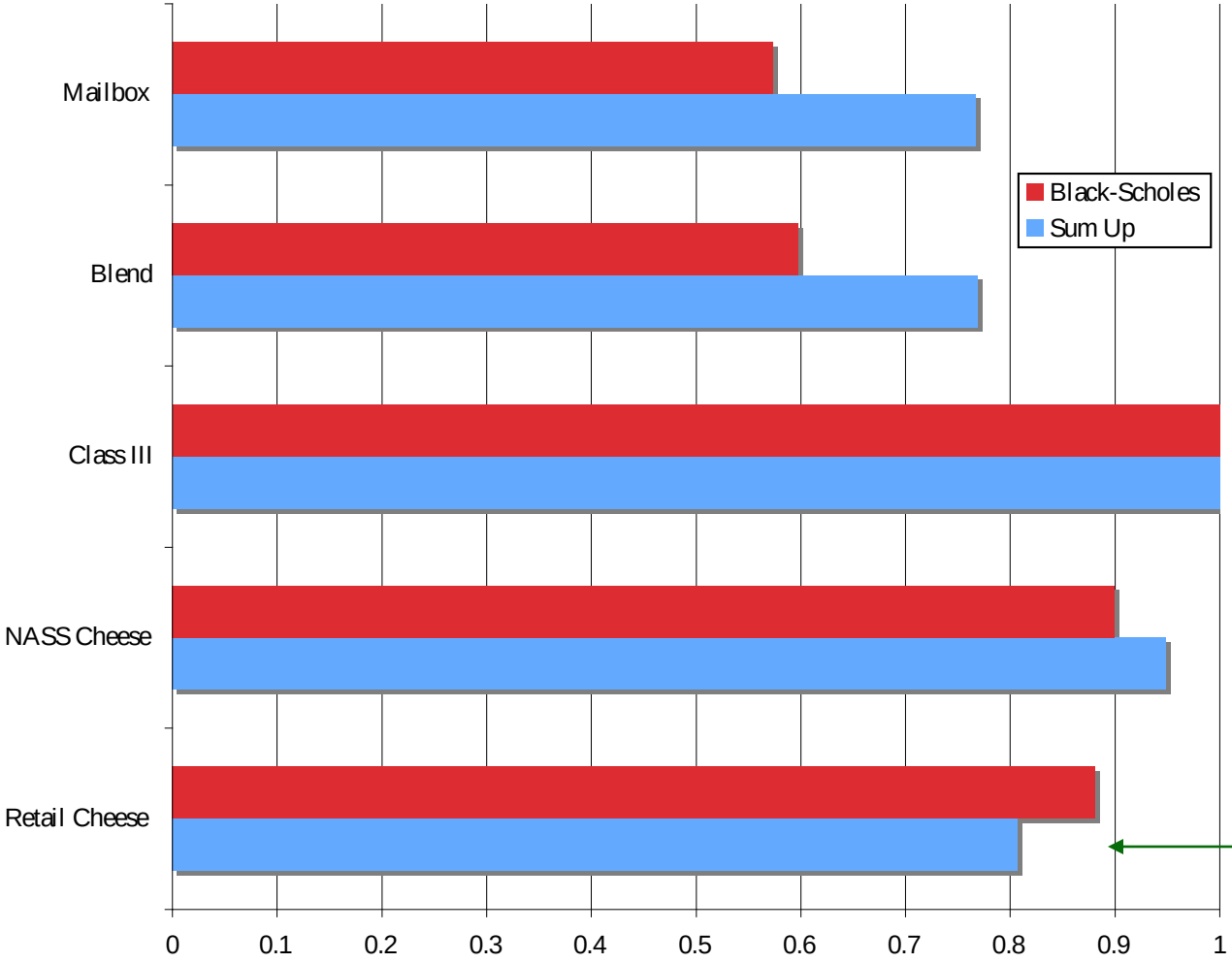
What Alternatives are Available to Measure Variability?

There are other econometric or statistical tools available to measure the frequency of changes, as opposed to the magnitude of changes.

Let's look at two

1. As simple counting of how many times the price rises over a period of months
2. A more complex formula used in finance and engineering to measure volatility

Ranking Volatility in Dairy Prices Using These Two Measures



Volatility Rank:

1. Class Prices
2. Wholesale Prices
3. Retail Prices
4. Farm Prices

If we look at Sum Ups, Farm and Retail are comparable. Farm is less using B-S

Retailers change prices less frequently, but do not exhibit less volatility.

What Have We Learned From a Larger Study of Dairy Prices?

- Volatility is highest in the middle of the marketing chain—product and product formula prices
  - Wholesale Butter and Cheese prices are very volatile.
  - Nonfat dry milk wholesale prices have not been volatile.
  - Cheese prices are the most volatile retail dairy prices
  - Beverage milk and butter prices are not volatile and these are highly explained by trend
- Volatility is somewhat muted or altered at the farm and retail levels

What Have We Learned From a Larger Study of Dairy Prices?

Different measures of farm level prices exhibit different degrees of volatility

- The price that plants pay (All Milk), including premiums, is less volatile than the price farmers receive (Mailbox)
  - ✓Farm marketing costs are less volatile than the pay price
- The regulated minimum farm price (Blend) is more volatile than either the All Milk and the Mailbox prices
  - ✓Processors tend to smooth price fluctuations by changing premiums

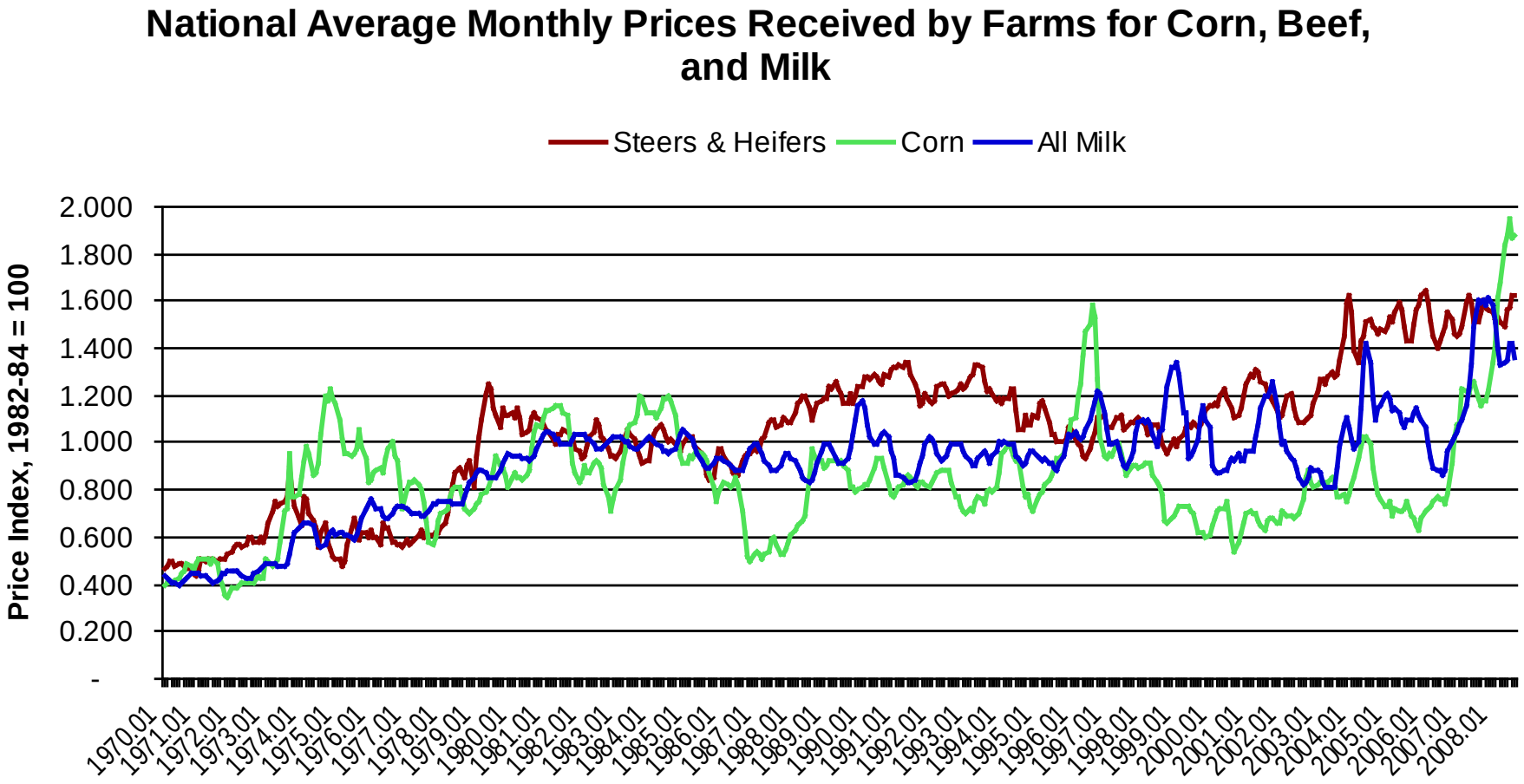
Federal Order minimum classes, assigned to processors of four different categories of dairy products, exhibit different price volatility

- Class I (fluid) and Class III (cheese) are by far the most volatile
- Class IV (butter and nonfat dry milk) is the least

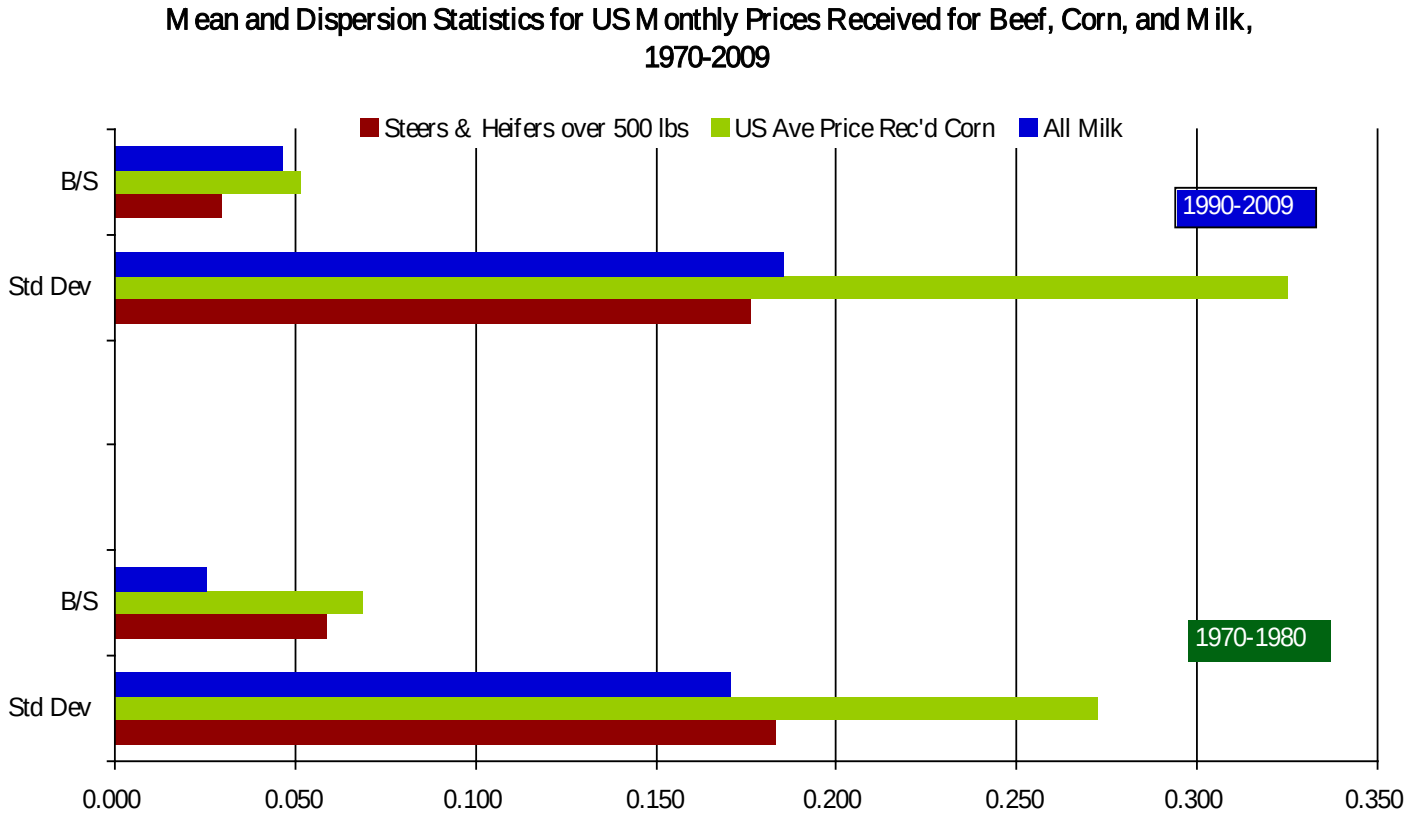
There are regional differences in farm/plant price volatility

- Florida (which is dominated by fluid milk - Class I) has by far the most volatile prices
- Northeastern states, like New York, having a balance across class utilizations are less volatile

What is Variability in Dairy vs Beef or Corn? (plenty!)



Comparative Measures of Price Volatility for Milk, Corn, and Cattle, Black-Sholes vs Standard Deviation



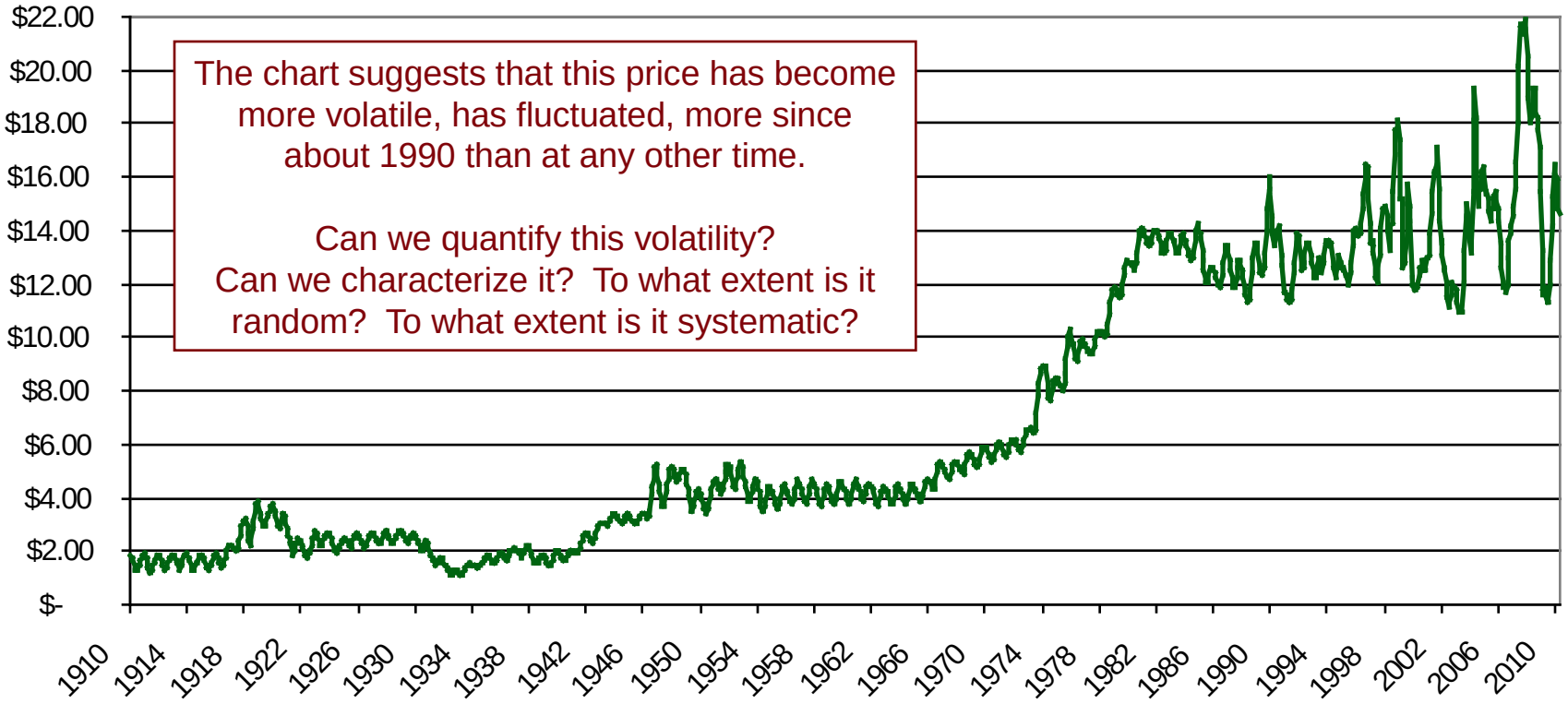
Using either measure, only cattle prices have reduced "volatility" after 1990 compared to 1970-80.

However, using SD, milk is more like cattle in both time periods.

Whereas when measured by B/S, cattle is like corn in the 1970s and milk matches corn after 1990.

Let's look at "volatility" in the US Average Price for All Milk

Figure 1. U.S. Average Monthly Price for All Grades of Farm Milk, 1910 to 2010
(not adjusted for inflation)



The chart suggests that this price has become more volatile, has fluctuated, more since about 1990 than at any other time.

Can we quantify this volatility?
Can we characterize it? To what extent is it random? To what extent is it systematic?

More than one kind of pattern though

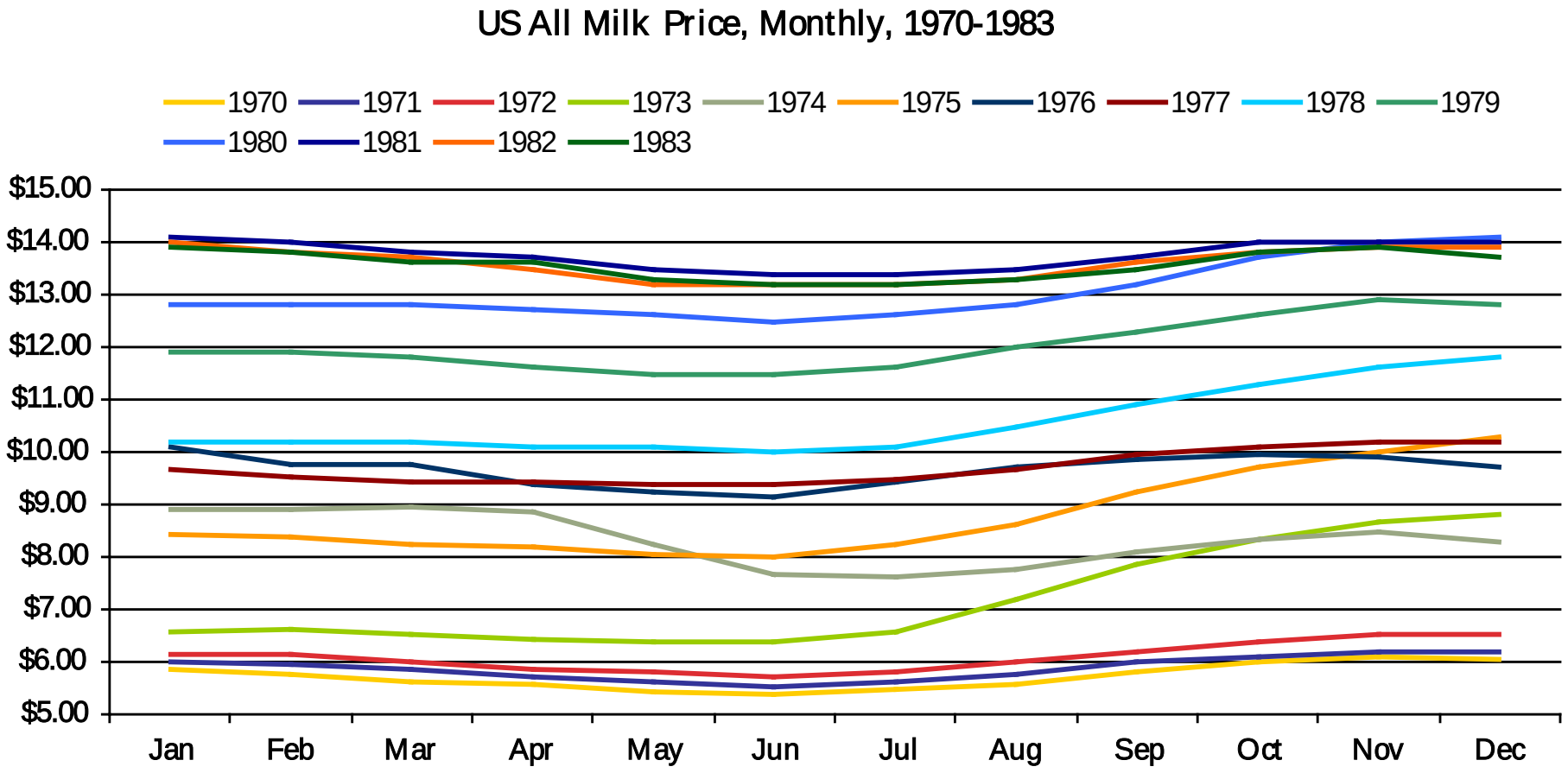
Milk prices have several different patterns

- ✓ Trend in annual averages
- ✓ Seasonality in monthly prices
- ✓ Cyclical behavior in annual or monthly prices

Causes of patterns are understood to varying degrees

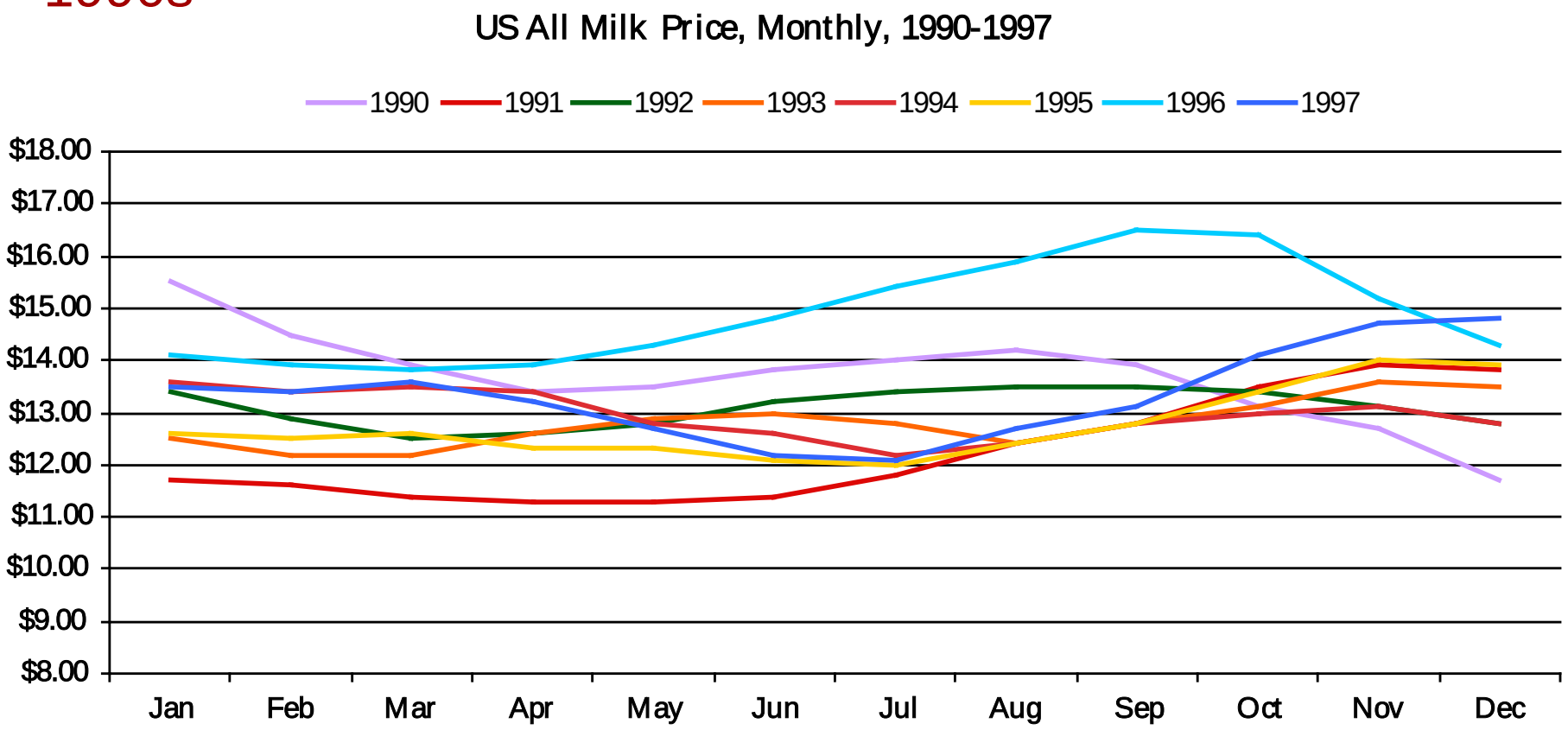
- ✓ Price trend responds to long term trends in production and consumption
- ✓ Seasonal patterns reflect in large part the seasonal differences in milk production vs milk needs
- ✓ Cyclical behavior is new
  - Complicates the seasonal pattern
  - Has causes that are not well known or understood

Traditionally, average milk prices to farmers had a distinct seasonal pattern, rising in the fall and declining in the spring.



CPDMP
Cornell Program on Dairy Markets & Policy

The severe reduction in the Support Price for Milk by the end of the 1980s resulted in more erratic price behavior, however, the seasonal pattern remained dominant in the 1990s



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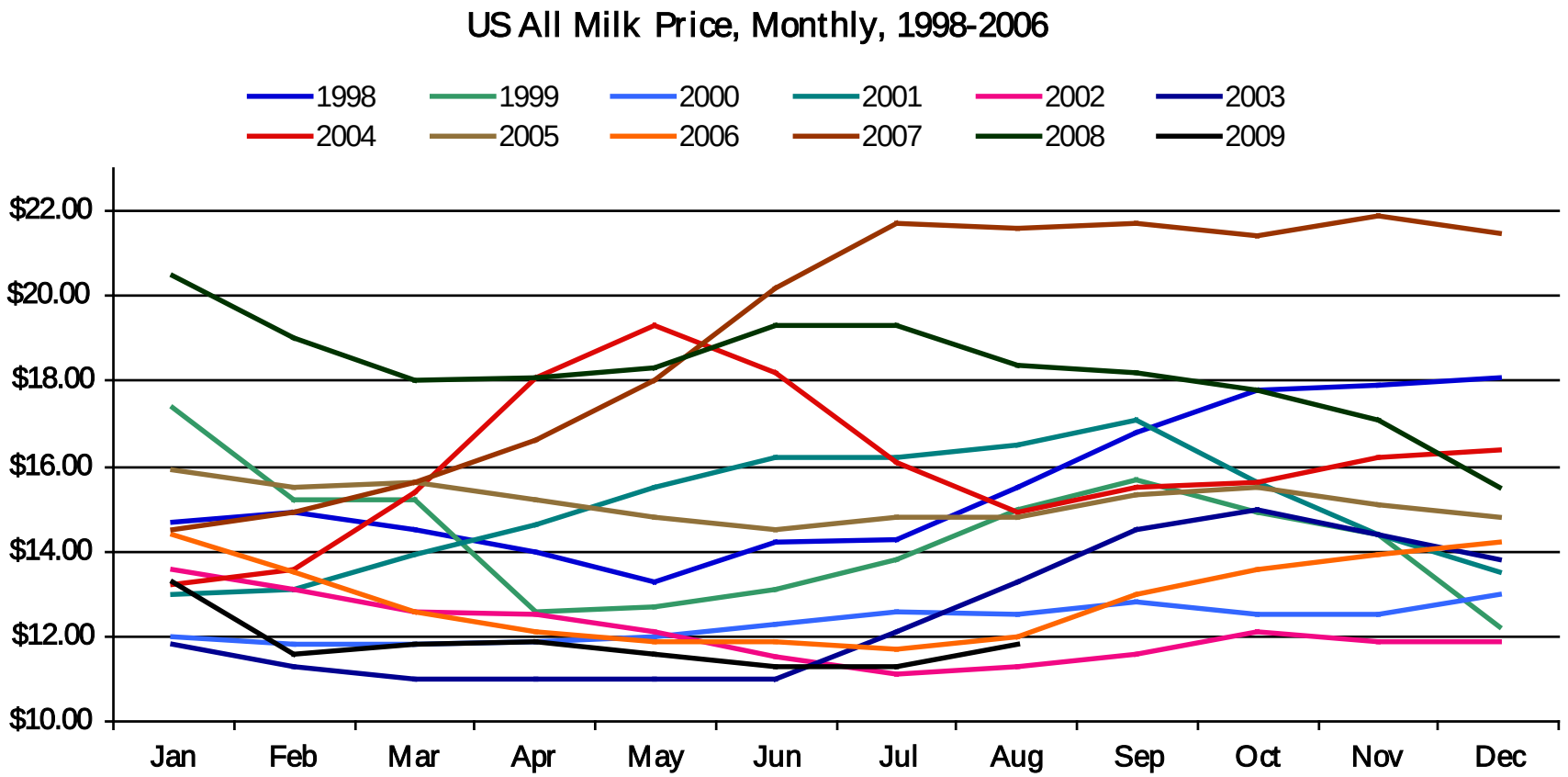
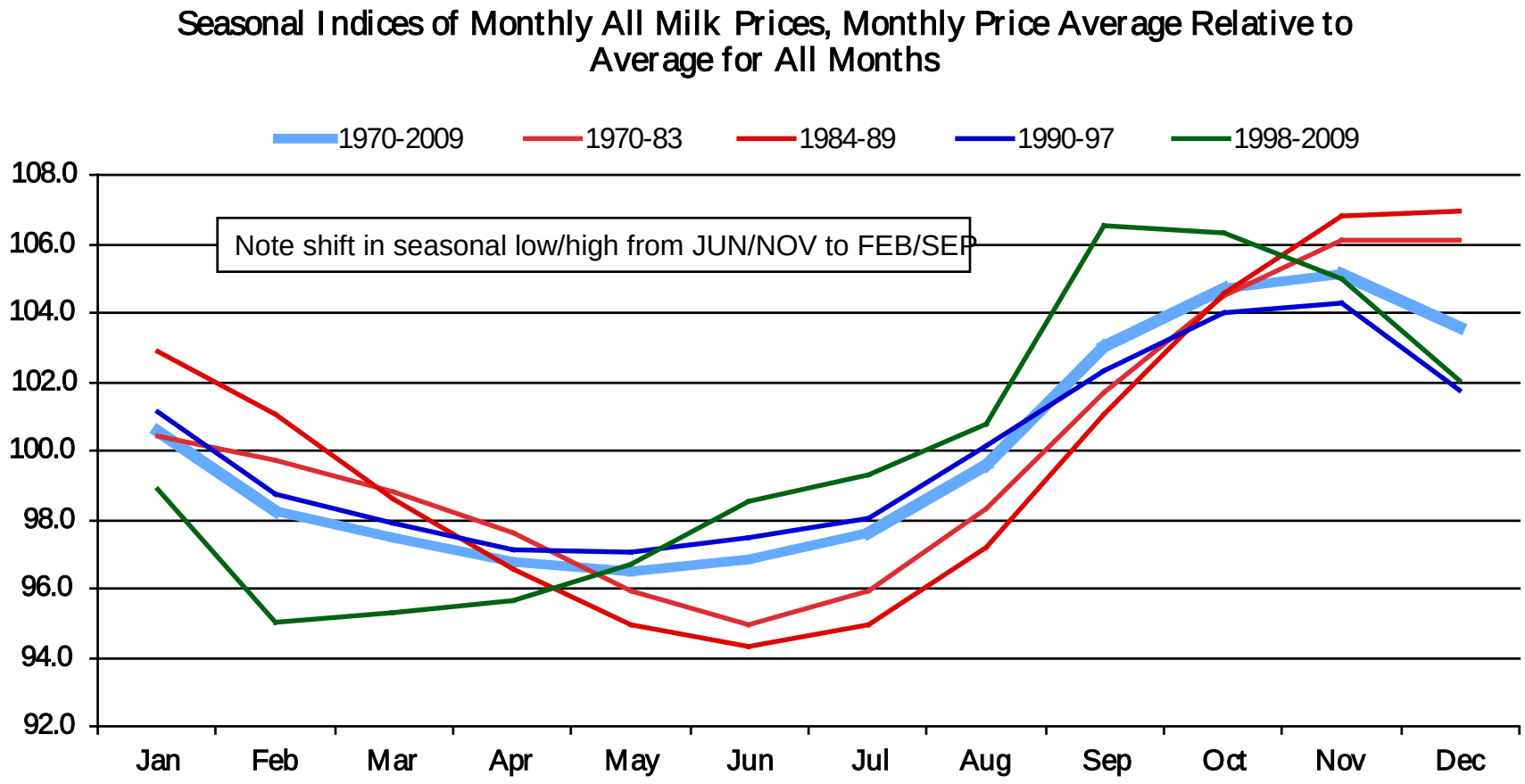
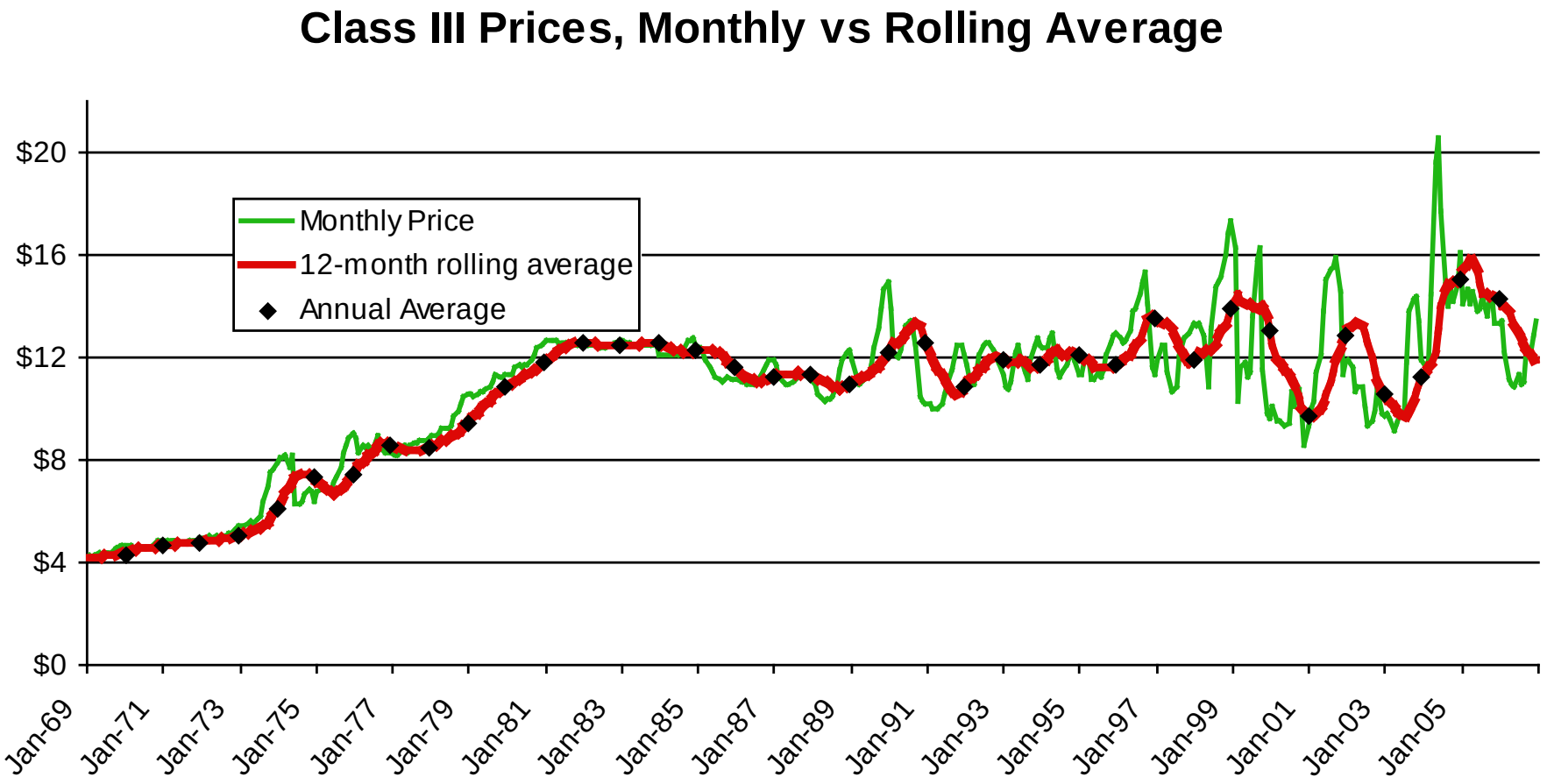
Prices are much more erratic since 2000.



Normalized average seasonal price patterns for four time periods since 1970 indicate that there is still an underlying seasonality.



12-Month Rolling Average Reveals What Looks Like a New Cyclical Pattern in the Class III Price, beginning in mid-1990s



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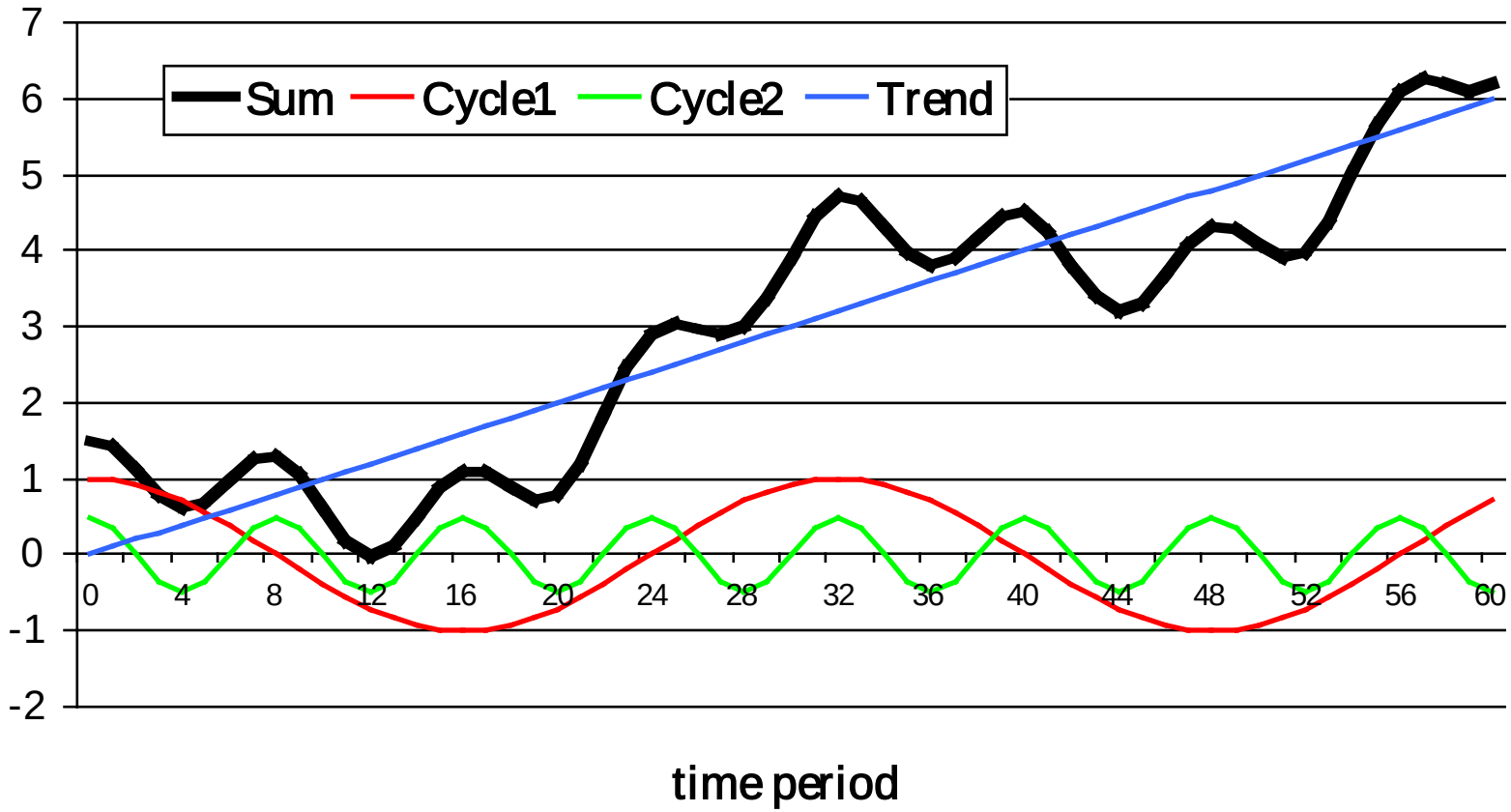
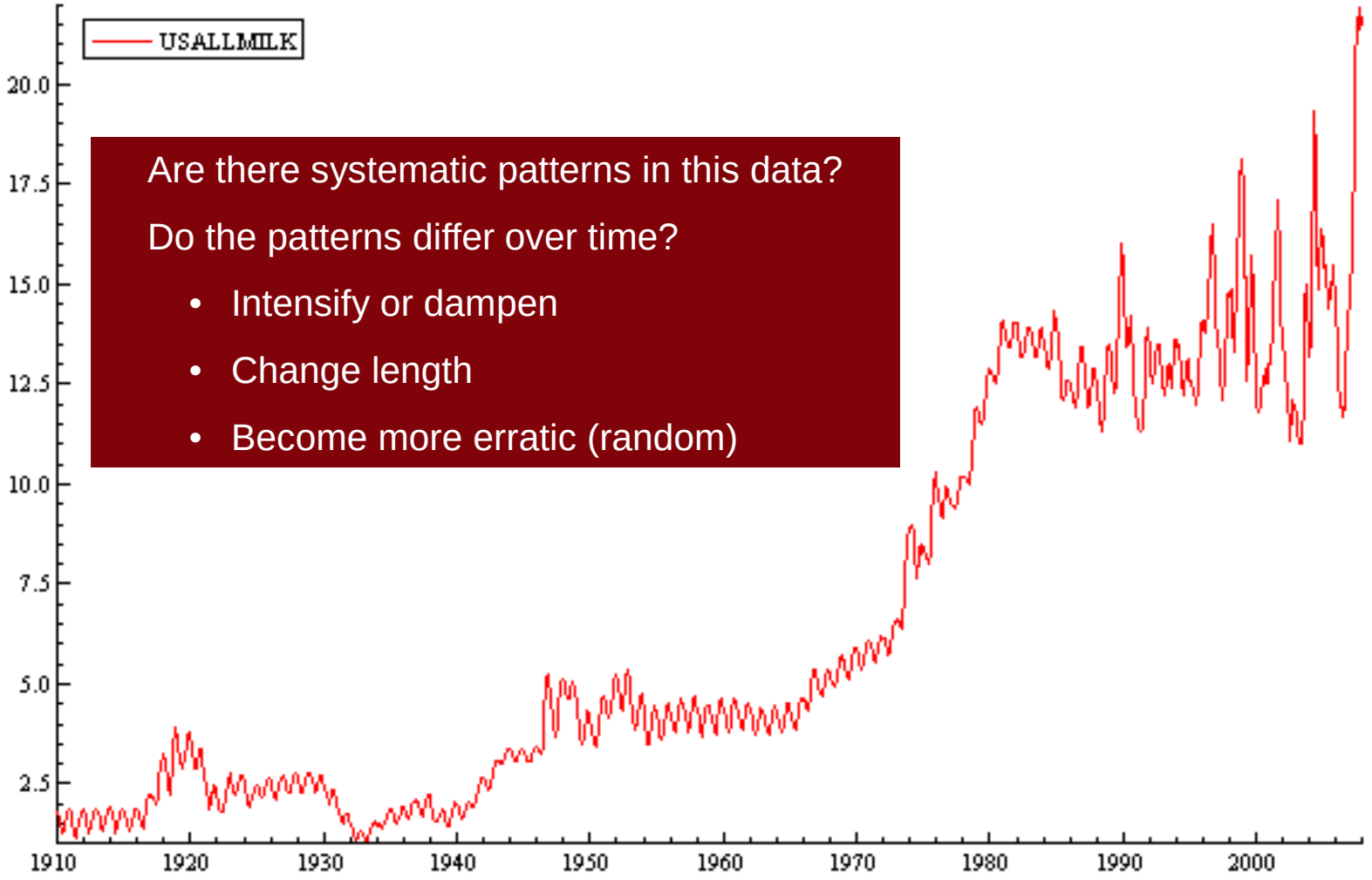
Identifying and Measuring Milk Price Cycles Using Time Series Analysis - Suppose we have a data series that looks like:



Sum of three underlying series, each with different characteristics

Consider the All Milk Price



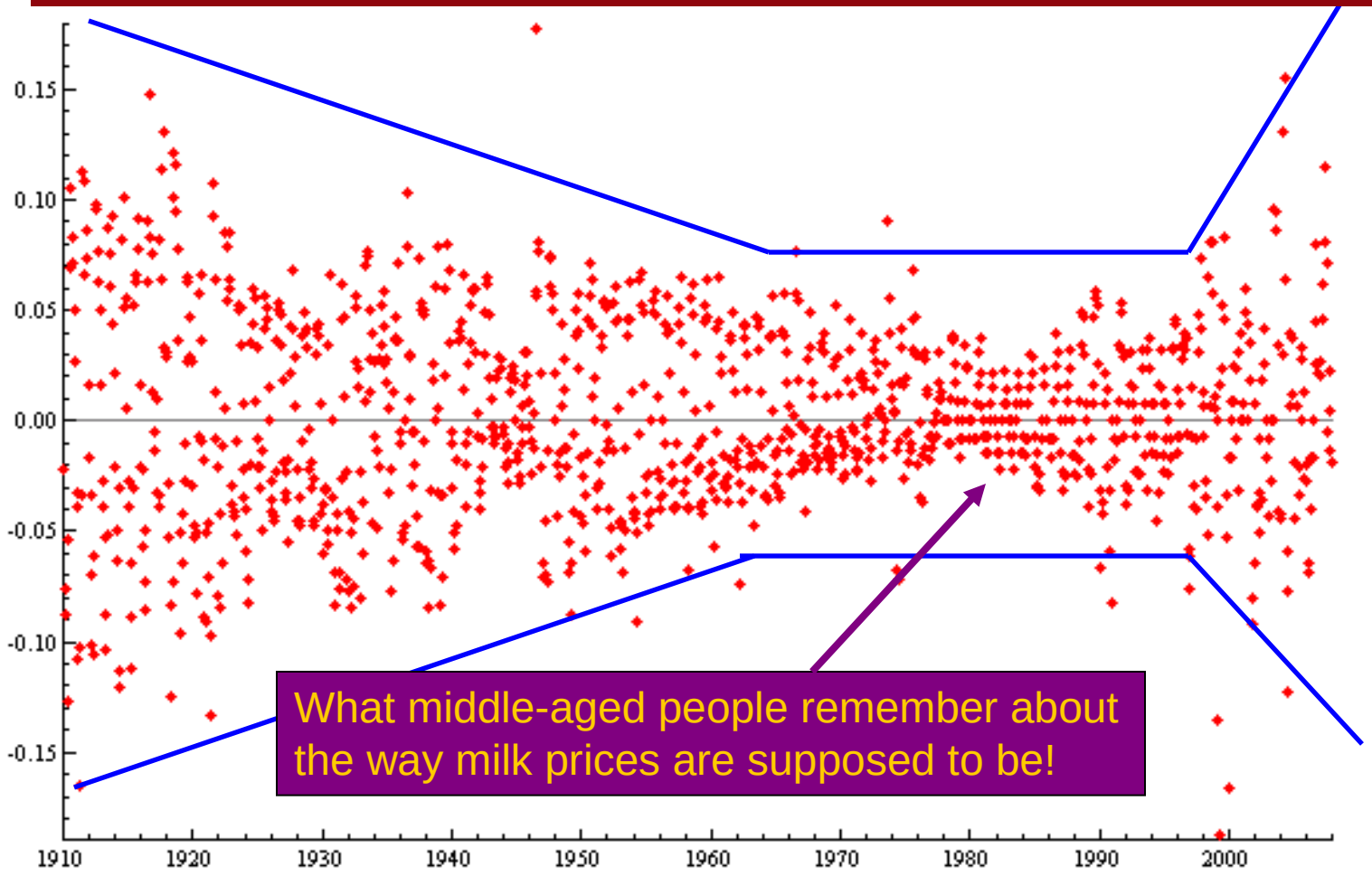
Are there systematic patterns in this data?

Do the patterns differ over time?

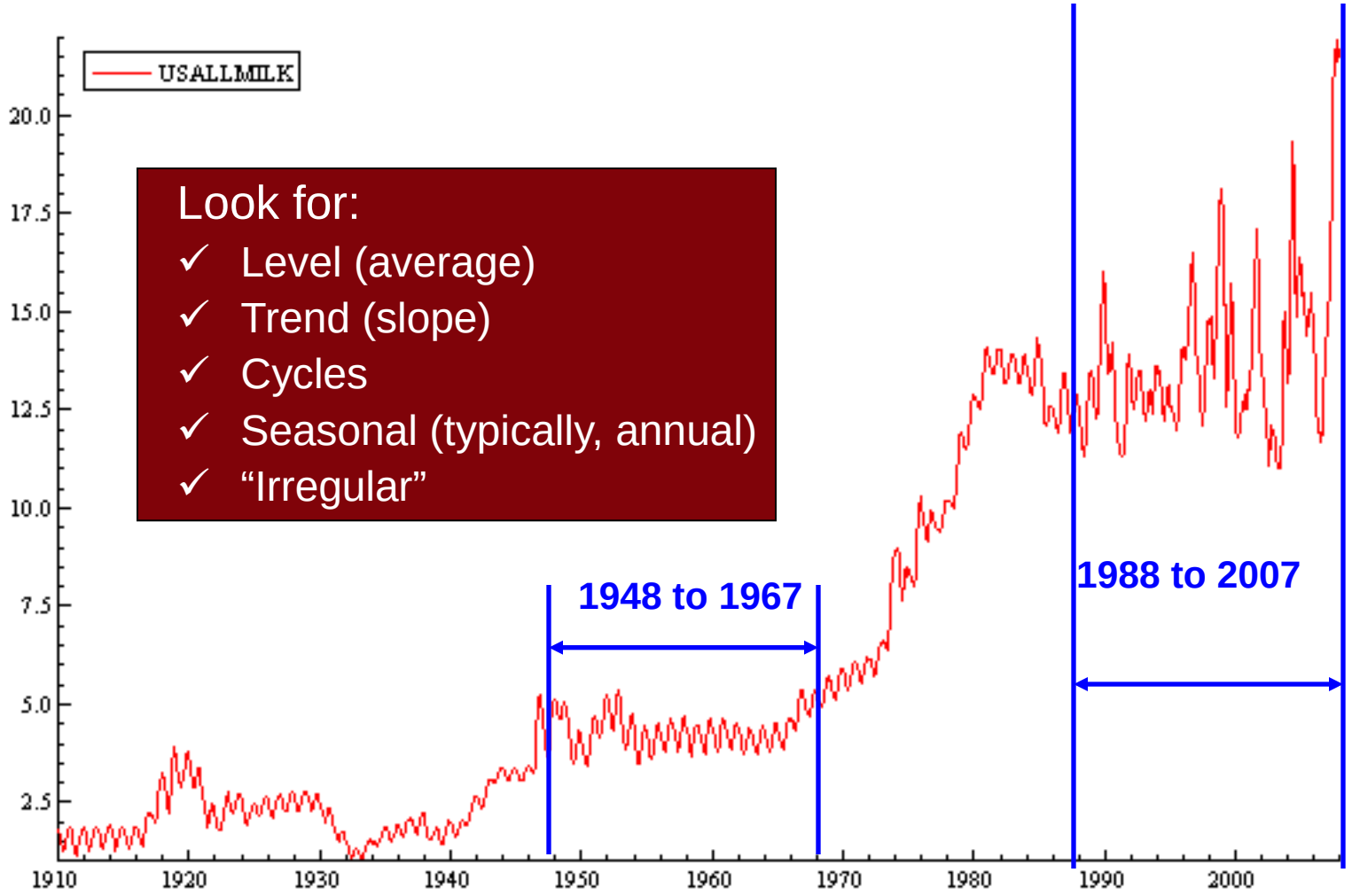
- Intensify or dampen
- Change length
- Become more erratic (random)

Relative Variability over time, percent change from one month to the next

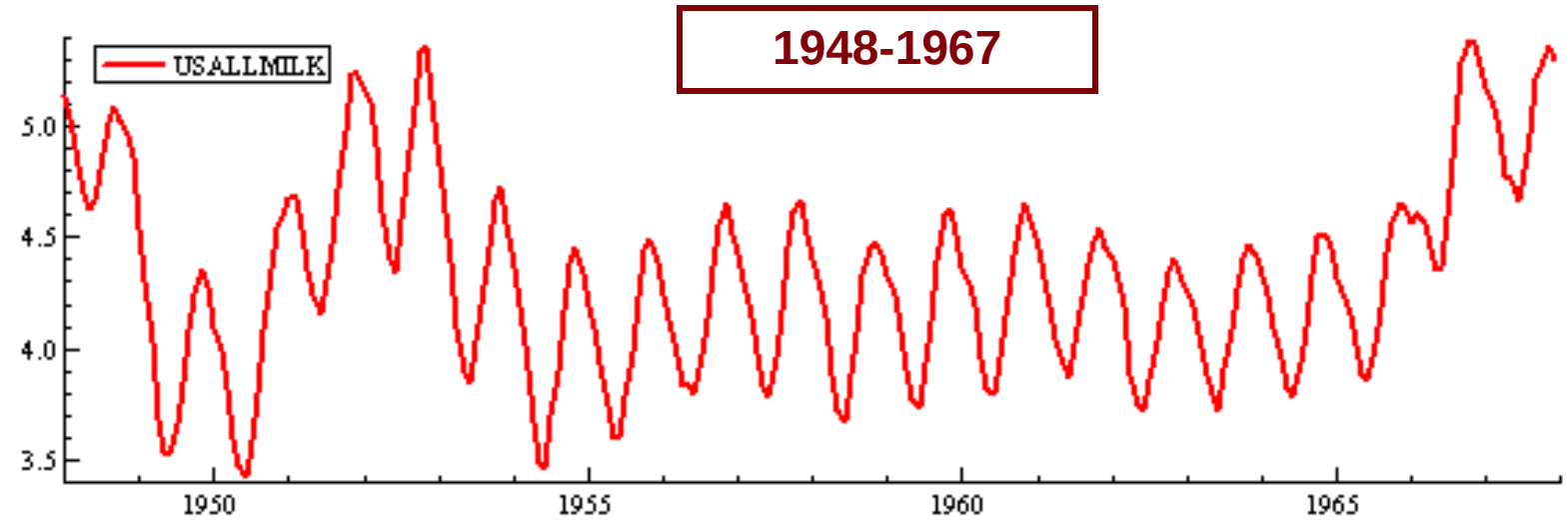
Current variability is of similar magnitude to early 20th century – but less predictable?

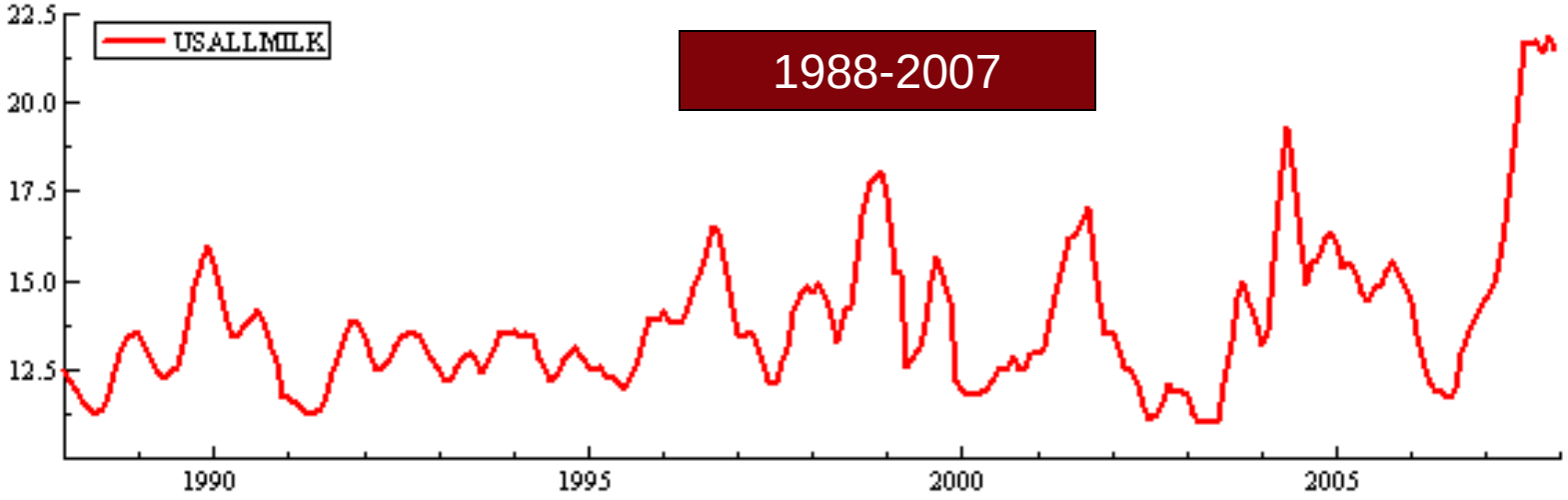


Analyze Two Time Periods



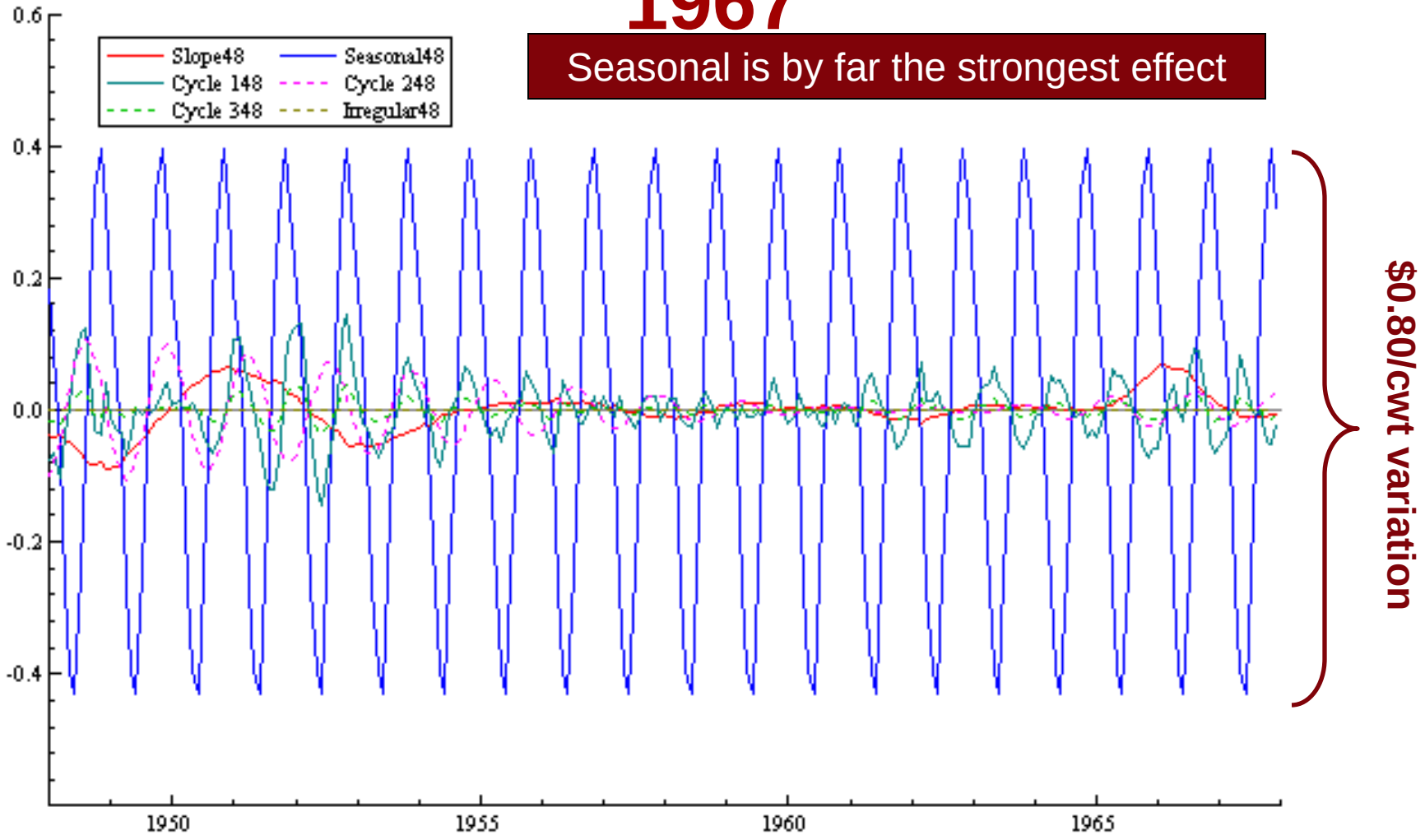
Closer View of 2 Series



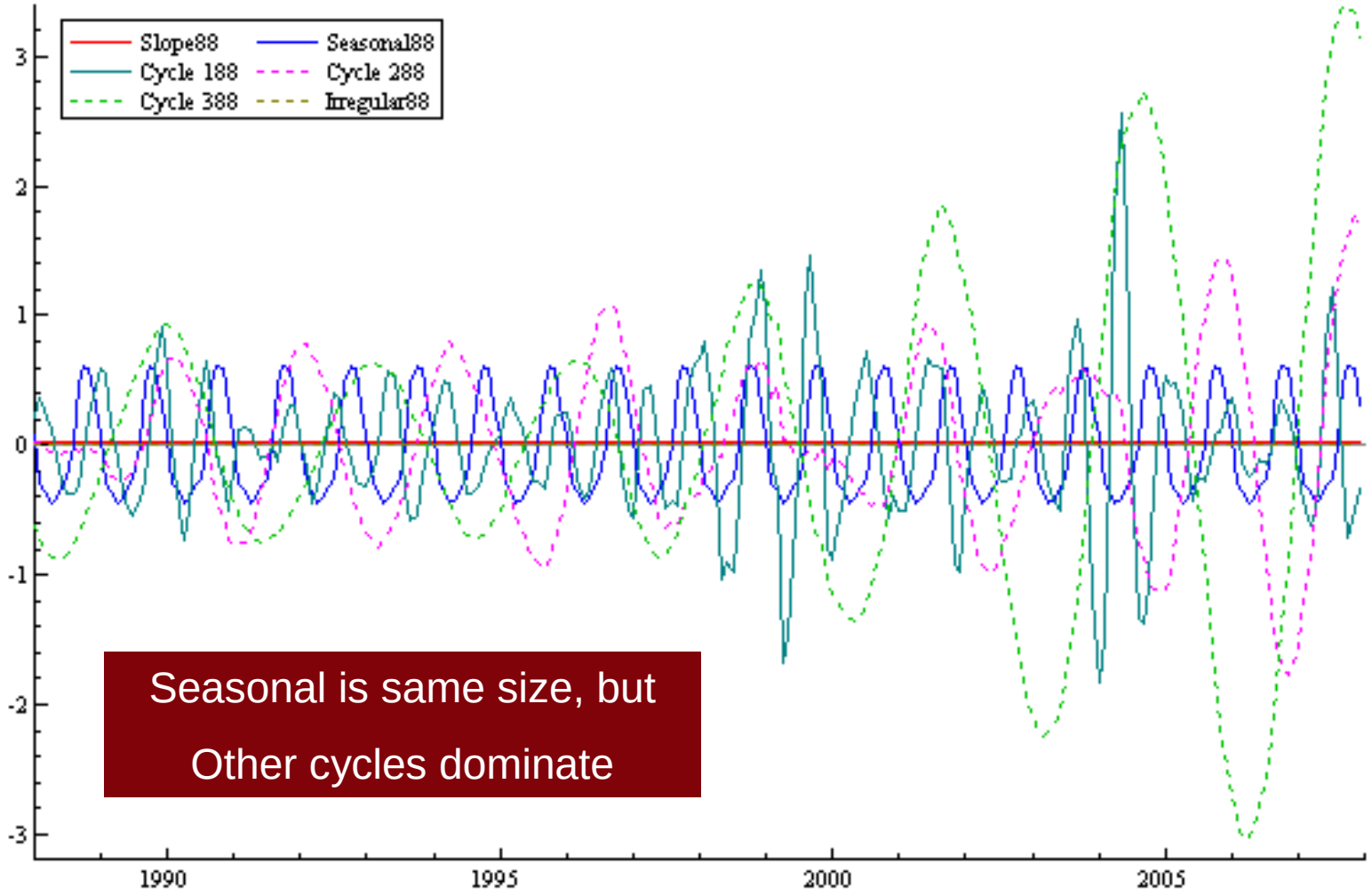


Frequency Components, 1948 to 1967

Seasonal is by far the strongest effect



Frequency Components, 1988 to



Seasonal is same size, but

Other cycles dominate

Amplitude of cycles increasing

$6 per cwt variation.

Key Results of Spectral Analysis

Dominant components vary

- Seasonal component dominates 1948-67
- Longer cycles dominate 1988-2007

Several Cycles in 1988-2007

- Triennial, 36-month cycle - large and exploding
- Biennial, 26-month cycle - quite large and exploding?
- Annual, 12-month cycle - smaller, erratic
- 9-month cycle - small and stable

Variation much larger 1988-2007

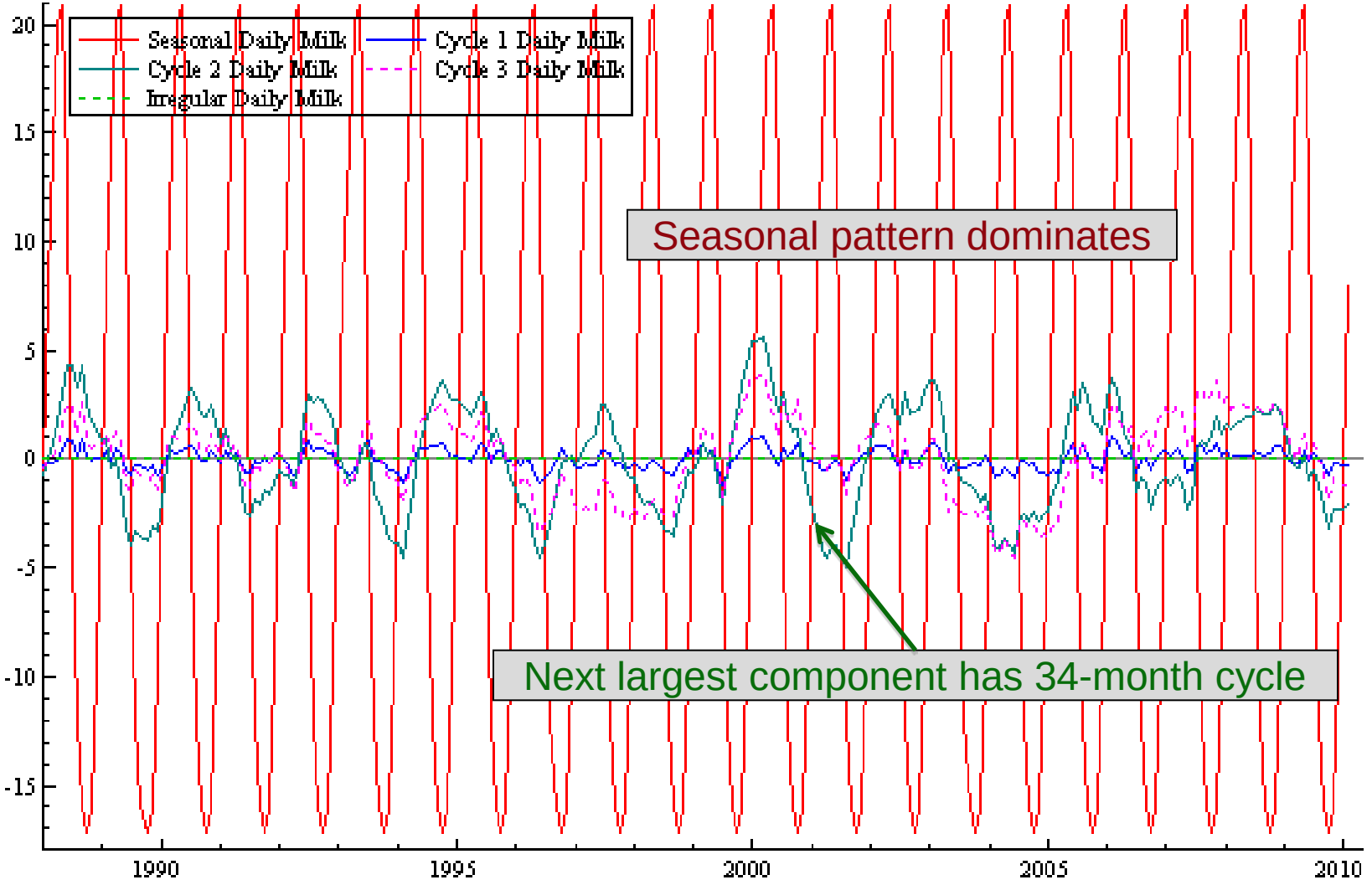
- Model explanatory power the same for both

The analysis was recently extended

- More recent data
- More variables
- Questions
  - ➥ Are there similar patterns in other dairy prices?
  - ➥ Are there similar patterns in other dairy variables (production, stocks, sales)?
  - ➥ Can we begin to discern causes and effects?

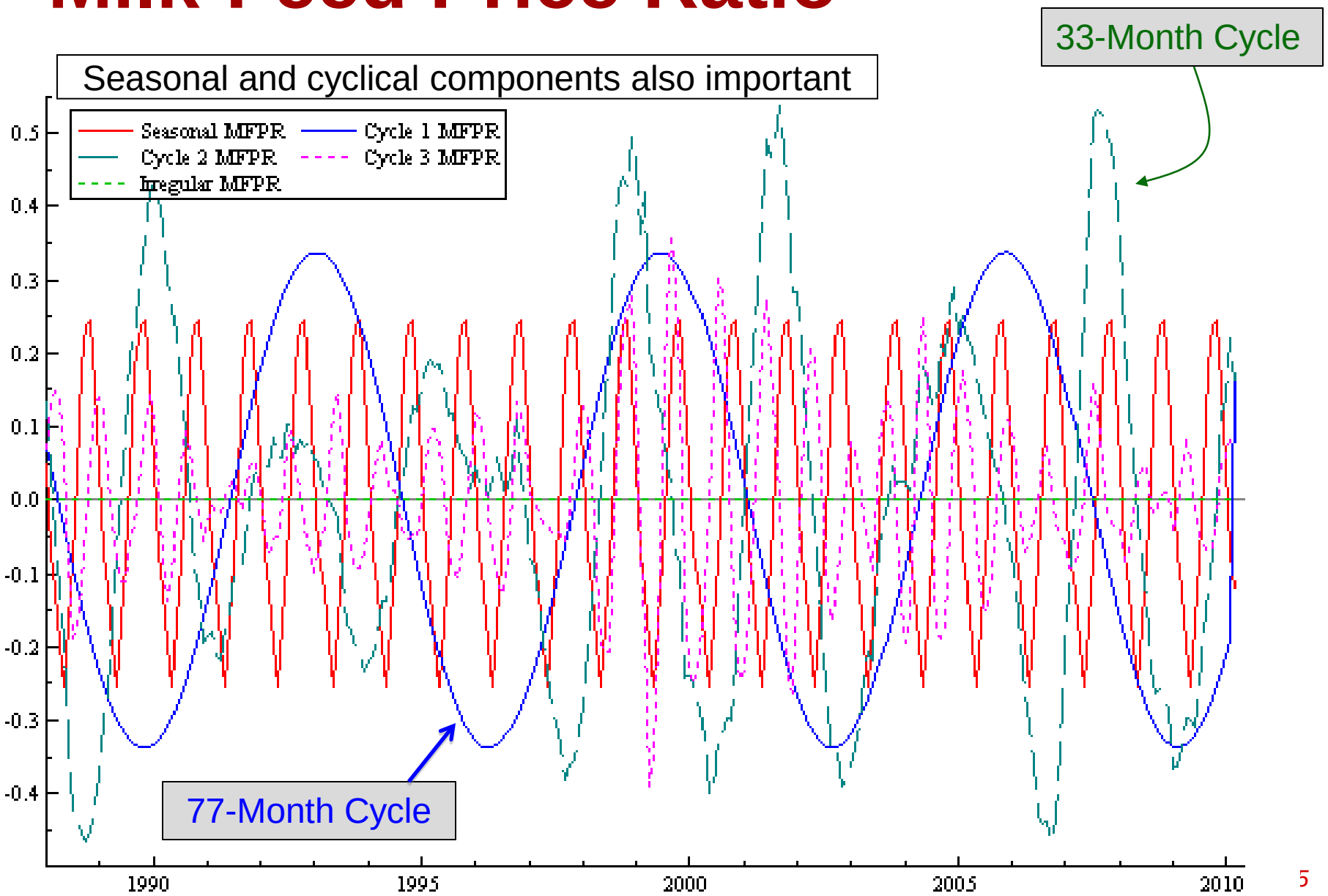
Daily Milk Production

Seasonal and cyclical components

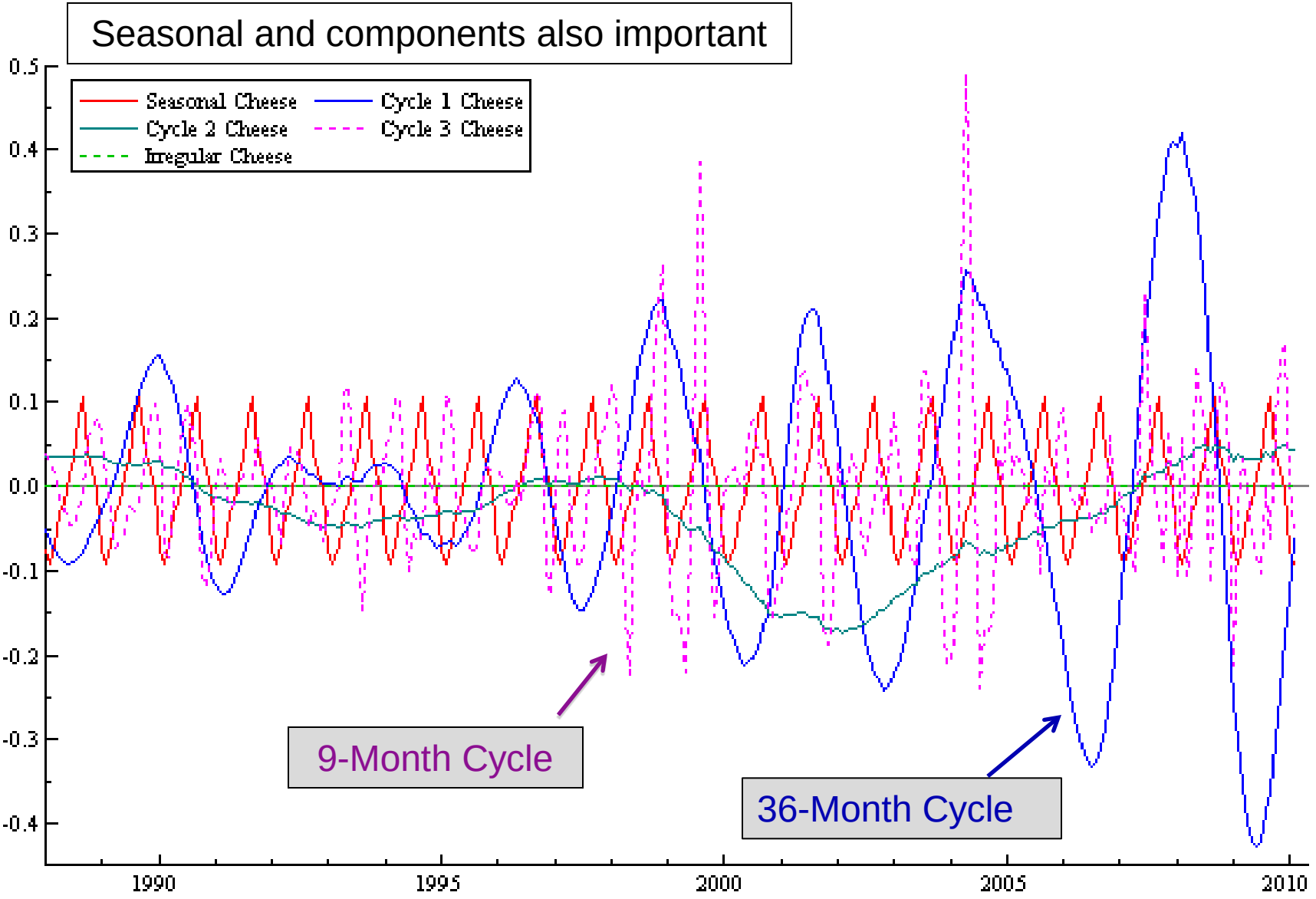


Milk-Feed Price Ratio

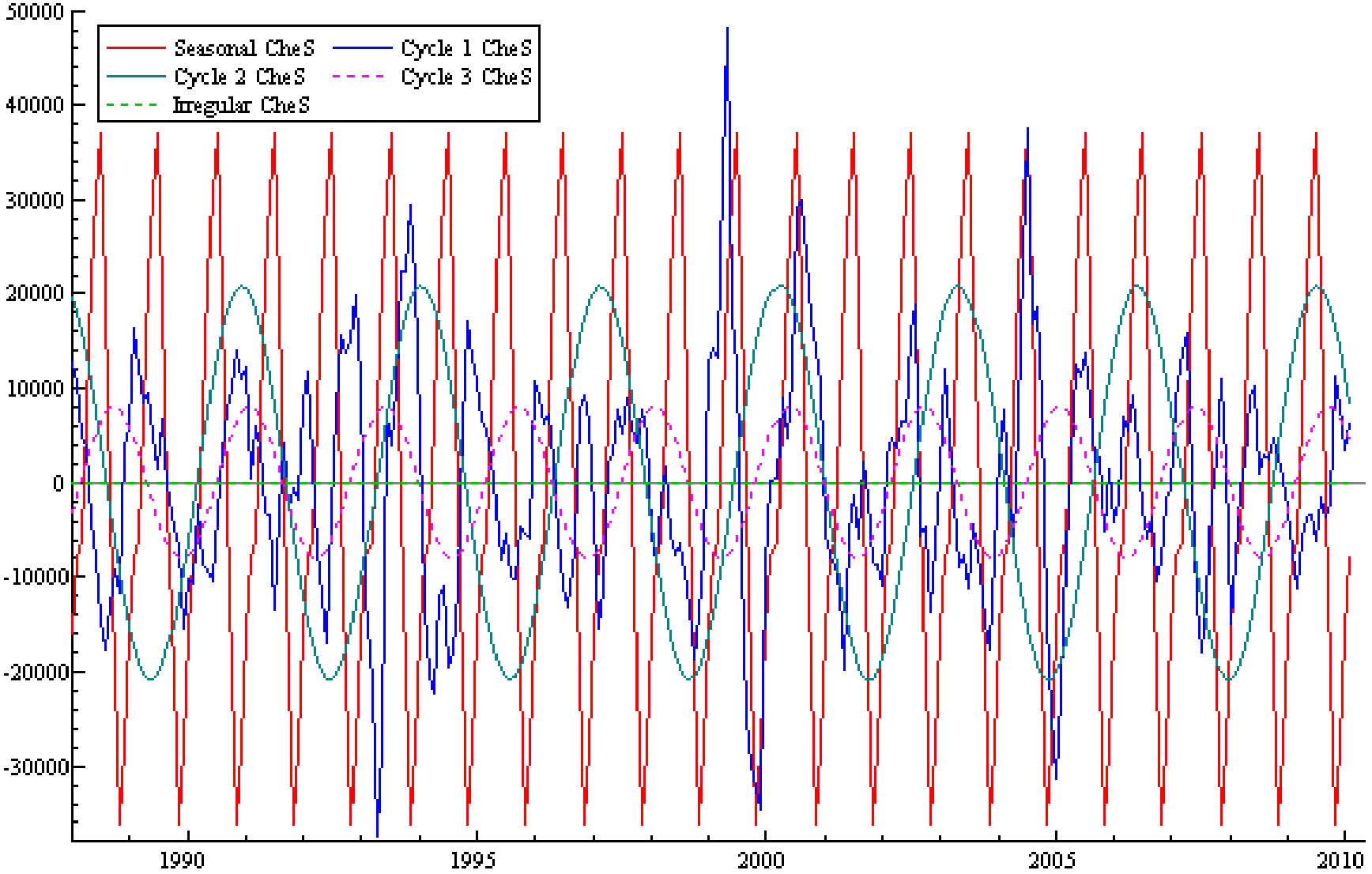
Seasonal and cyclical components also important



Cheese Price



Commercial American Cheese Stocks



Summary of Results - Estimated Cycle Lengths (all series showed trend and seasonal patterns too)

Variable	< 1 year	1-2 years	3 years	Longer	Really Long
CommÕl NDM Stocks	11	11	29		
Milk-Feed Price	10		33	77	
Daily Milk Production			34	64	139
NDM Price	9	13	34		
Class IV price	10		34		
All Milk Price	10	17	36		
Cheese Price	9		36		
Butter Price	10	17	36		
Class III Price	9	28	37		
CommÕl Cheese Stocks	6	16	37		
CommÕl Butter Stocks	9	12	44		

Size or Strength of Patterns

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	**36-month**	**$9.00/cwt**
Daily Milk Production	235 mil lbs	40 mil lbs	**34-month**	10 mil lbs
Milk-Feed Price	1.2	0.5	**33-month**	**1.0**
Cheese Price	$0.30/lb	$0.20/cwt	**36-month**	**$0.80/lb**
Whey Price*	$0.50/lb	$0.05/lb	**34-month**	$0.09/lb
Class III Price	$4.00/cwt	$1.60/cwt	**37-month**	**$8.00/cwt**
NDM Price	$0.65	$0.10/lb	**34-month**	**$0.70/cwt**
Butter Price	$0.75	$0.20/lb	**36-month**	**$0.70/lb**
Class IV	$4.00/cwt	$2.00/cwt	**34-month**	**$8.50/cwt**

*Since 2000

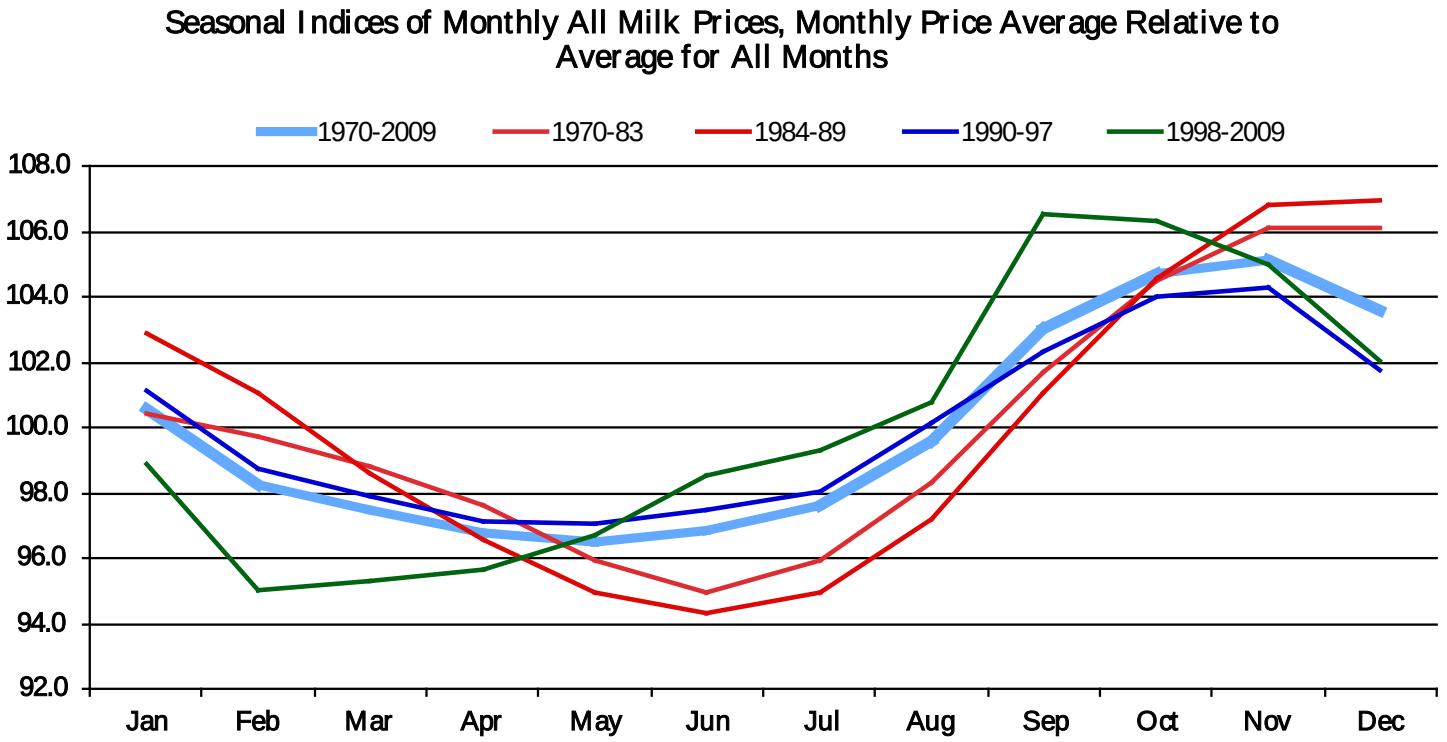
Cyclical component is large relative to range and(or) seasonal

Rough convergence of periods of largest cycles

Concluding Comments: Seasonality

Seasonality is less obvious but remains a distinct element of US price patterns

- Farm milk prices have a distinct seasonal pattern, with lows in the early spring and highs in the fall.
- The seasonal nadir and zenith of milk prices has shifted as milk production has moved to the Southwest
- New cycles obscure seasonal component



Concluding Comments: Cycles

Longer-period cycles have become defining feature in last 20 years

- Question: Why?
- Beef and other agricultural sectors show cycles related to price-induced expansion and contraction in capital assets, is that it for dairy
- What role does dairy demand play?
- Has expanding role of world trade increased volatility? (contrary to economic theory?)
- Increased volatility is consistent with results from other dynamic economic modeling work at Cornell that incorporates elements of market behavior and psychology (can we learn our way out of this?)

Farm Milk prices are now among the most volatile in US agriculture

Milk Production and Prices

- Although seasonal fluctuations in milk production are larger, cyclical deviations from trend and season appear highly correlated with milk price cycles
  - With delays (not in perfect phase)
  - 34-month cycle
- Does this suggest that much of the variation arises from production deviations?
  - Maybe/likely
  - More formal work to be done, other factors

What can/could be done?

Existing Policy or Public Tools -

- Federal Milk Marketing Orders
- Dairy Price Supports
- Milk Income Loss Contracts
- Something old? (Dairy Termination Program, Marketing Agreements)
- Something new? (Growth Management, Margin Insurance)

Private or Collective/Cooperative Tools -

- Hedging (outputs, inputs, options, etc)
- Insurance (LGM-D, FSA)
- Contracting (price and quantity specified forward contracts)
- CWT

Cornell Program on Dairy Markets and Policy

For more information or a copy of this presentation:
http://www.dairy.cornell.edu

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