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New Generation of Standards and Potential Impacts of Food Borne Illness Incidences on Market Movements and Prices of Fresh Produce in the United States

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Outline

- Introduction
- Objectives
- Data and Scope
- Methodology
- Results and Discussion
- Summary

Introduction

- The US is the safest food supply in the world
- Incidents in many agricultural sectors- especially processed foods
- Fresh fruits and vegetable Industry perception
- Industry Trend – Direct Marketing

Introduction

- According to the CDC, more than **76 million** people *are affected*; and **5,000 die** as a result of *food poisoning every year.*

- The most common food-borne illnesses are *Campylobacter, Salmonella, and Escherichia Coli*

- *E. coli O157:H7 most common. (22 leafy green outbreaks in past 12 years) – all 22 indicated a California source*

Introduction

- Consumers react to a food safety alert by immediately reducing consumption
- Unknown source, origin, etc.- shut down movements.
- Reduction in sales depends on severity of the outbreak:
    - Number of people affected
    - Number of deaths
    - Regional scope
    - Type of products
    - Origin

Introduction

- There are also longer term impacts on consumption
- The entire supply chain may face legal liability
- Longer term impacts may be several weeks, months or even years, depending on the severity of the outbreak

Objectives

- This paper will study both, the contemporaneous and lagged effects of food borne illness in the fresh produce industry
- Differences in source (domestic vs imported)
- And the associated producer costs of the outbreaks.

Data and Scope

- Three case studies were used to assess the potential impacts of outbreaks on product shipments and prices.
- Specifically, we analyzed:
  - The spinach outbreak of September, 2006;
  - The cantaloupe outbreak of March-April 2008;
  - The tomato outbreak of June-July 2008.

Data and Scope

- Data were weekly shipments (domestic and imports) and average prices of spinach, cantaloupes, and tomatoes for the periods around the outbreaks.
- Fruit and Vegetable news portal – Agricultural Marketing Service (AMS), United States Department of Agriculture (USDA)

Methodology

- The model explores how information is communicated across the three variables, *price, imports and shipments* for each vegetable in a neighborhood around outbreaks.

- The empirical analysis is based on a vector autoregression (VAR) model in which directed acyclic graphs are used to sort-out causal flows of price information in contemporaneous time.

Methodology

- Let

$$X_t = \begin{pmatrix} P_t \\ I_t \\ S_t \end{pmatrix}$$

Weekly prices, imports, and shipments of each vegetable at time period t.

The structural VAR representing a N x 1 vector of variables Xt can be written as:

$$\Phi_0 X_t - \sum_{k=1}^{K} \Phi_i X_{t-k} = \varepsilon_t$$

Methodology

Under general conditions permitting matrix inversion an equivalent form exists:

$$X_t - \Phi_0^{-1}\Phi_1 X_{t-1} - \cdots - \Phi_0^{-1}\Phi_k X_{t-k} = \Phi_0^{-1}\varepsilon_t$$

The reduced form (non-structural) VAR is written as:

$$X_t - \Pi_1 X_{t-1} + \cdots + \Pi_k X_{t-k} = u_t$$

Where $\Pi_h = \Phi_0^{-1}\Phi_h$ for k=1, …, K and $u_t = \Phi_0^{-1}\varepsilon_t$

Methodology

- While the reduced form VAR has been "championed" as atheoretic, the key to model structural VARs is proper identification of the matrix A_0.
- Bernanke (1986) and Sims (1986) used prior theory to achieve such identification.
- More recent work follows that of Swanson and Granger (1997) to use the causal pattern exhibited by observed $\hat{u}_t$ innovations to identify Φ_0.
- In this paper we use the machine learning algorithms of Spirtes, Glymour and Scheines (2000) as applied earlier in Bessler and Akleman (1998) and Hoover (2005) to achieve structural identification.

Methodology

The dynamic price relationships can be best summarized through the moving average representation where the vector Xt is written as a function of the infinite sum of past innovations:

$$X_t = \sum_{i=0}^{\infty} \Theta_i u_{t-i}$$

Which map historical innovations at lag i into the current position of vector X.

Once the price innovations are orthogonized, the historical decomposition of the vector X at time t=T+k can be divided into 2 parts:

$$X_{T+k} = \underbrace{\sum_{s=k}^{\infty} \Theta_s u_{T+k-s}}_{\text{Base projection}} + \underbrace{\sum_{s=0}^{k-1} \Theta_s u_{T+k-s}}$$

Base projection

Info available up to T

Info available from T+1 until T+k – including outbreaks

Methodology

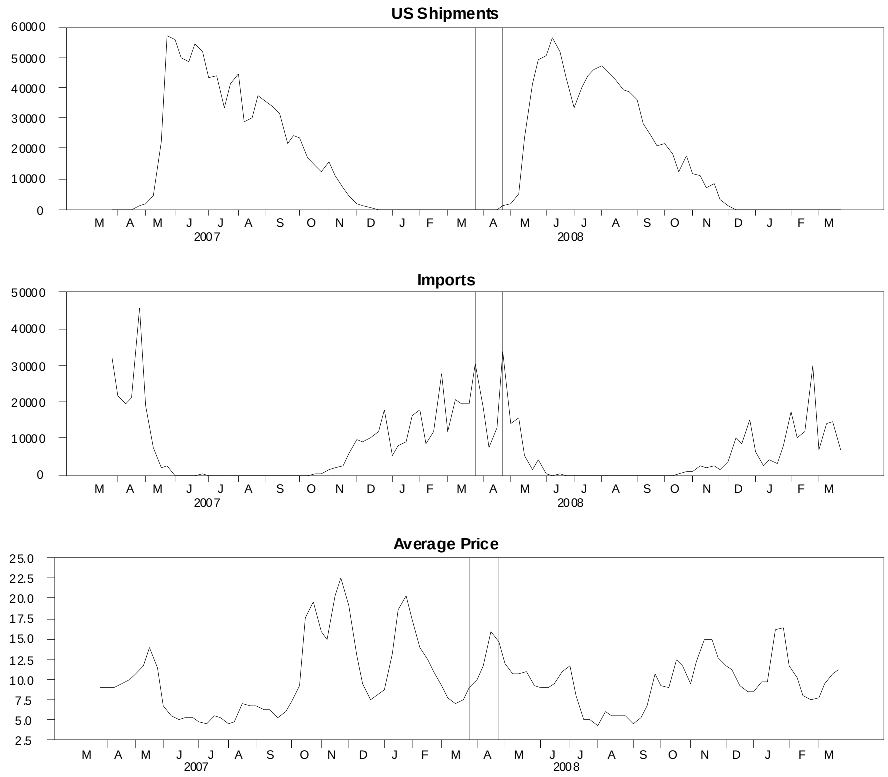
The difference between the actual price and the base price projection is written as a linear function of innovation (new information) between T and T+k.

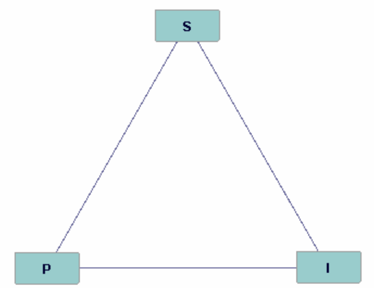
$$\underbrace{\left(X_{T+k}\right)}_{\textit{Actual price}} \; - \; \underbrace{\left(\sum_{s=k}^{\infty}\Theta_s \varepsilon_{T+k-s}\right)}_{\textit{Base price projection}} \longrightarrow \left(\sum_{s=0}^{k-1}\Theta_s \varepsilon_{T+k-s}\right)$$

Through the partition:

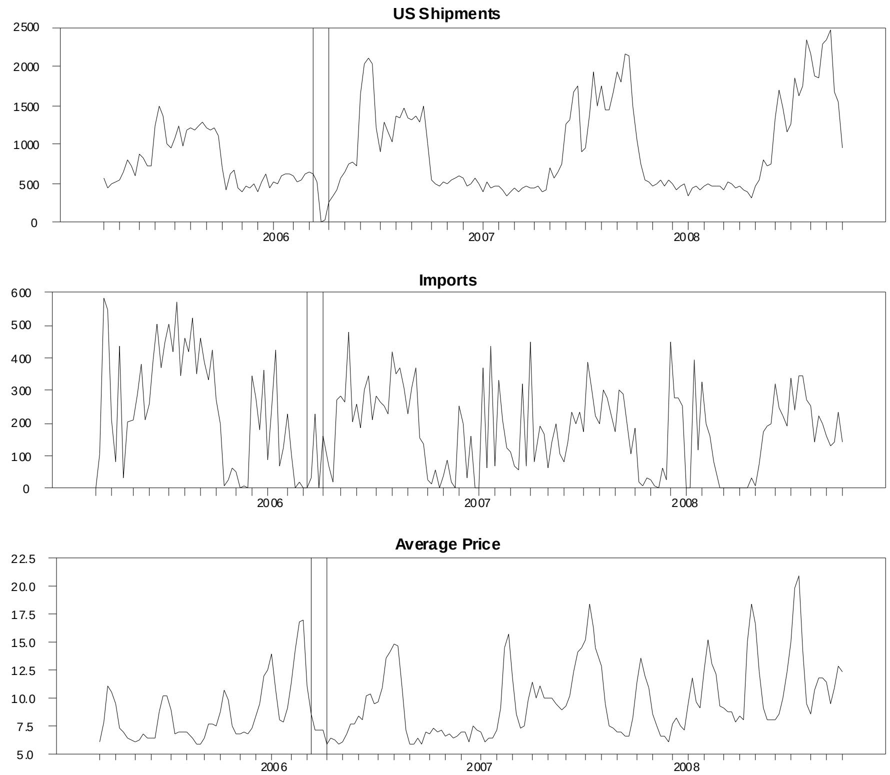
- Analyze the behavior of each price series in the neighborhood of the outbreaks
- Infer how much each innovation contributes to the unexpected variation of X_{T+k}

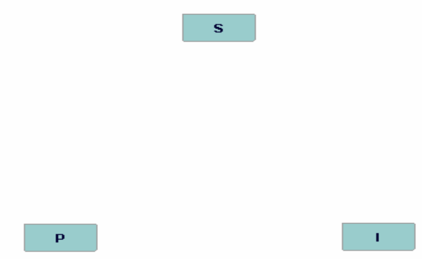
Results - Cantaloupes



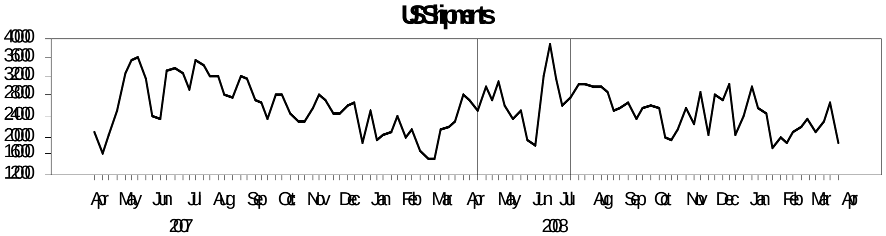


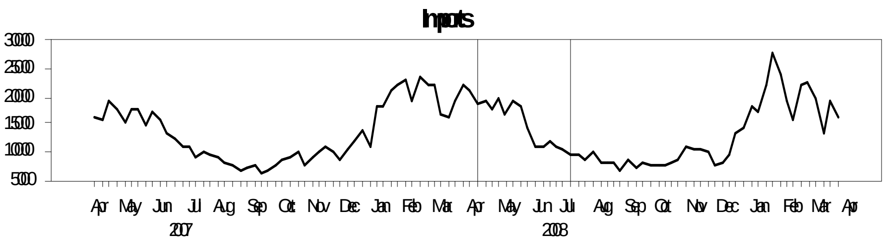
Results - Spinach

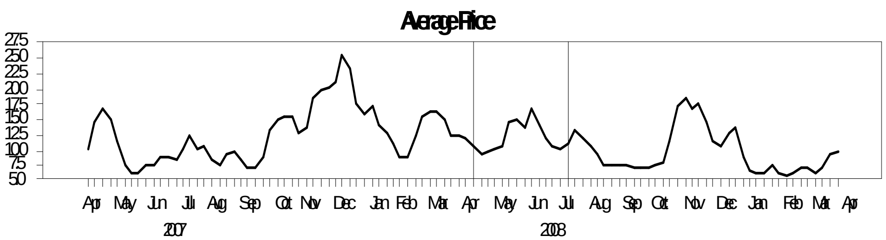


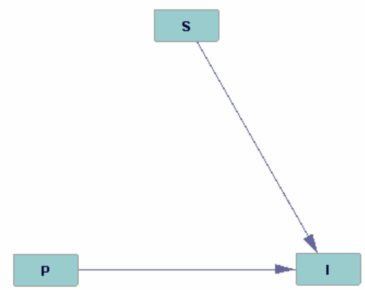


Results - Tomatoes









Results

Table 1. Historical Decomposition of Cantaloupe Price in a Neighborhood of the March 22, 2008 and April 26, 2008 Event.

(1) Date	(2) Difference = Actual Price Minus Forecasted Price	(3) Due to Information Arising from Domestic Shipments	(4) Due to Information Arising from Imports	(5) Due to Information Arising from Price
March 22, 2008	-0.02	0.00	0.00	-0.02
March 29, 2008	0.19	-0.16	-0.49	0.84
April 5, 2008	-0.72	-0.33	-2.21	1.82
April 12, 2008	0.59	-0.14	-1.54	2.28
April 19, 2008	4.70	0.34	0.17	4.19
April 26, 2008	3.51	1.06	0.45	2.00

Note: This table decomposes the difference between the Actual Price and the Forecasted Price at each date, between March 29, 2008 and April 26, 2008. That difference at each date can be attributed to information arising in the domestic shipments variable, the imports variable and the price variable. Accordingly, the column labeled (2) is decomposed at each date into the sum of columns (3), (4) and (5).

Results

Table 2. Historical Decomposition of Spinach Price in a Neighborhood of the September 9, 2006 and October 4, 2006 Event.

(1) Date	(2) Difference = Actual Price Minus Forecasted Price	(3) Due to Information Arising from Domestic Shipments	(4) Due to Information Arising from Imports	(5) Due to Information Arising from Price
September 2, 2006	-4.12	0.00	0.00	-4.12
September 9, 2006	-4.29	-0.00	0.04	-4.33
September 16, 2006	-3.81	0.00	0.09	-3.88
September 23, 2006	-3.87	0.01	0.13	-4.02
September 30, 2006	-3.42	0.02	0.00	-3.44
October 7, 2006	-3.20	-0.26	0.01	-2.96
October 14, 2006	-2.49	-0.60	0.07	-1.96

Note: This table decomposes the difference between the Actual Price and the Forecasted Price at each date, between September 2, 2006 and October 14, 2006. That difference at each date can be attributed to information arising in the domestic shipments variable, the imports variable and the price variable. Accordingly, the column labeled (2) is decomposed at each date into the sum of columns (3), (4) and (5).

Results

Table 3. Historical Decomposition of Tomato Price in a Neighborhood of the April 12, 2008 and July 19, 2008 Event.

(1) Date	(2) Difference = Actual Price Minus Forecasted Price	(3) Due to Information Arising from Domestic Shipments	(4) Due to Information Arising from Imports	(5) Due to Information Arising from Price
April 12, 2008	1.76	-0.15	-0.91	2.82
April 19, 2008	0.26	-0.28	-0.74	1.27
April 26, 2008	-0.91	-0.12	0.03	-0.82
May 3, 2008	-0.09	-0.24	0.20	-0.05
May 10, 2008	0.35	-0.23	0.60	-0.02
May 17, 2008	0.78	-0.41	0.42	0.77
May 24, 2008	4.34	-0.28	0.94	3.68
May 31, 2008	5.06	0.28	0.44	4.34
June 7, 2008	3.44	0.58	0.32	2.54
June 14, 2008	6.41	1.22	0.94	4.25
June 21, 2008	4.06	2.19	1.20	0.67
June 28, 2008	1.99	1.75	0.76	-0.52
July 5, 2008	0.72	0.27	0.43	0.02
July 12, 2008	-0.01	-0.66	0.00	0.65
July 19,2008	0.34	-0.59	-0.56	1.50

Note: This table decomposes the difference between the Actual Price and the Forecasted Price at each date, between April 12, 2008 and July 19, 2008. That difference at each date can be attributed to information arising in the domestic shipments variable, the imports variable and the price variable. Accordingly, the column labeled (2) is decomposed at each date into the sum of columns (3), (4) and (5).

Summary

- Similar results for Cantaloupes and Tomatoes (both had original warnings linked to a foreign source)
- Actual prices were higher than forecasted prices (mostly)
- For spinach there was an overall negative response in price following the event with most of this negative information *arising in the prices market*;
- Difference in source of the illness outbreak
- Short-term farm level costs to the industry is directly linked to the source, intensity, size of the industry, season, etc…

Questions

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