Identifying Dynamic Relationships and Market Structures among U.S. Dairy commodity prices

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Hernan A. Tejeda and Man-Keun Kim*

Objectives

1) Investigate the Dynamic Relationships among dairy market prices that conform classes of milk affecting dairy producers.
2) Identify the dynamic supply and demand structure of cheddar cheese and butter markets.

Introduction

- Dairy prices are mostly based on Federal Milk Marketing Orders (FMMO) programs that set a minimum monthly price for dairy production. The price dairymen receive is a function of milk use (e.g. cheese, butter, etc.) set by classes, and of revenue pooling
- Class I: fluid milk; Class II: fluid cream; Class III: cheese; Class IV: butter & dry milk. Class prices are computed from USDA wholesale market prices of butter, cheese, non-fat dry milk & dry whey. Class III derives from cheese, butter & dry whey; Class IV is from butter and nonfat dry milk
- In 2000, over 82% of milk was for process cheese and butter (Jeese and Cropp, 2008). In 2016, that amount was about 78%, with 14% dry milk and 8% whey (NMPF).
- Price transmission studies among dairy markets are few. Gould and Villareal (2002), Carvalho et al. (2015) and Newton (2016) studied effects from international markets, arriving at mixed results. Hahn et al. (2016) study dairy price transmission from farm to retailers.
- We fill the gap of identifying how U.S. dairy market prices dynamically evolve and if there's a reference market.
- More importantly, we study the dynamic effects from changes in supply and demand in the U.S. cheddar cheese and butter markets, a la Killian (2009).

Data & Methods

- **Obj. 1**: Monthly wholesale market prices for cheddar cheese, butter, dry milk & whey from Jan. 2000 to Dec 2016.
- **Obj. 2**: - Monthly prior cheddar cheese and butter prices adjusted by CPI; Cheddar cheese and butter production; Total Dairy Commercial Disappearance adjusted by CPI

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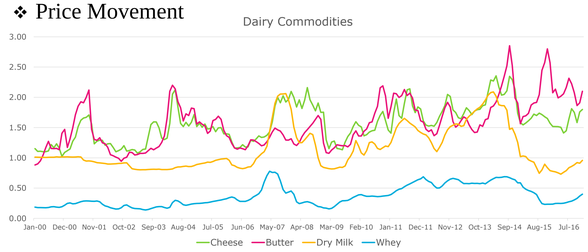
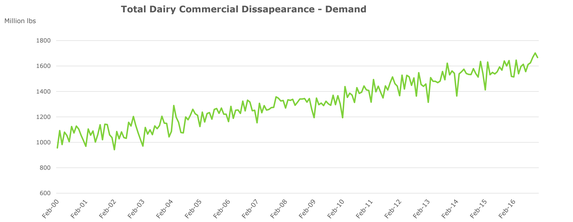
- Price Movement





- A reduced Vector Auto-Regression model with two (resulting) lags

$$\mathbf{y}_t = A_0 + \mathbf{A}_1\mathbf{y}_{t-1} + \mathbf{A}_2\mathbf{y}_{t-2} + \boldsymbol{\varepsilon}_t \quad (1)$$

where $\mathbf{y}_t' = [y_1, \cdots, y_4]$, and $\mathbf{A}_k$= 4×4 are coefficient matrices for kth lagged $\mathbf{y}$

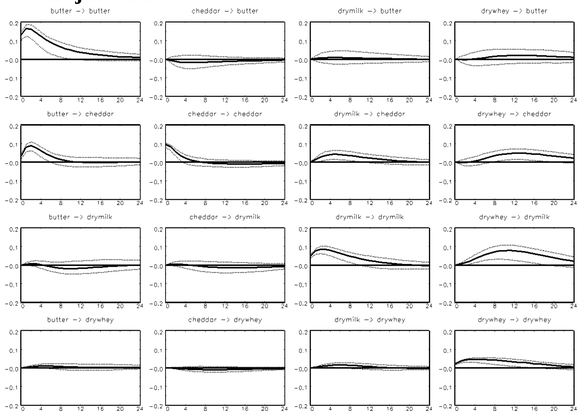
- Structural innovations $\boldsymbol{\varepsilon}_t$: (Lutkepohl, 2005)

$u_t = \boldsymbol{B}\boldsymbol{\varepsilon}_t$ and u_t are reduced form residuals

- Non-time directional causal flows calculated with Directed Acyclic Graphs (DAG) (see Pearl, 2000; Spirtes et al., 2000)
- Apply LinGAM algorithm (Lai & Bessler, 2015) to circumvent non-Gaussian innovations.
- Standard innovation accounting techniques are applied (i.e. IRFs and FEVD)

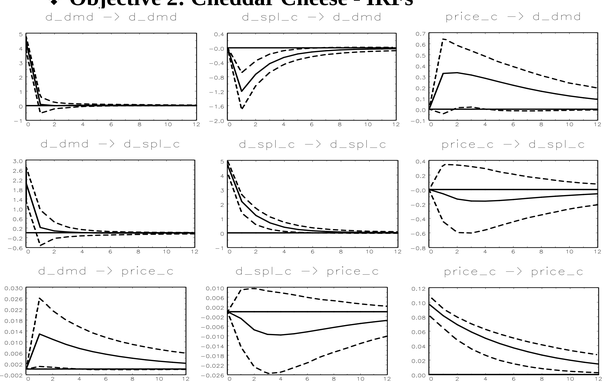
Results & Findings

- **Objective 1**



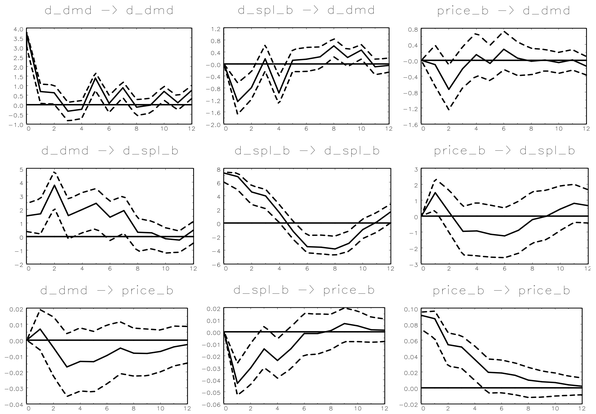
- **IRFs indicate:**
- Unexpected butter price shock affects cheddar prices up to 5 months ahead, but not vice-versa.
- Dry milk price shock affects cheddar prices and dry whey prices for up to 8 months ahead.
- Dry whey shock in price affects cheddar prices only after 8 months and up to 16 months ahead; it also affects dry milk prices for up to 20 months ahead.
- Butter prices are only affected by shocks to its own market.

- **Objective 2: Cheddar Cheese - IRFs**



- **IRFs indicate:**
- Unexpected total dairy market shock leads to a 1 month substantial increase in cheddar cheese production, and price increases for next 5 months.
- An unexpected cheddar cheese supply shock leads to a decrease of total dairy consumption (perhaps increase in cheddar cheese storage); and a non-significant drop in cheddar cheese prices.
- A cheddar cheese market specific (demand) shock leads to an increase in total dairy consumption. Also results in mild drop of quantity supplied, and significant rise in prices for over a year.

- **Objective 2: Butter - IRFs**



- **IRFs indicate:**
- Unexpected total dairy market shock lead to increase in butter production for following 7 months; and slight insignificant butter price increase/decrease.
- Unexpected butter supply shock (also) results in drop of total dairy consumption during first 4 months; moreover butter prices drop following first 5 months.
- Market specific (demand) shock drops total dairy demand during first 3 months (folks substituting away to non-dairy spreads), increases butter supply slightly in 1st month, and raises butter prices for following 5 months.

Acknowledgements

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