SEASONAL COST PASS-THROUGH IN THE GERMAN MILK MARKET

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2016

Paper prepared for presentation at the 56th annual conference of the GEWISOLA (German Association of Agricultural Economists)

„Agricultural and Food Economy: Regionally Connected and Globally Successful"
Bonn, Germany, September 28 – 30, 2016

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Abstract

The objective of this paper is to analyze the extent of seasonality in wholesale to retail cost pass-through for differentiated milk products in the German dairy market from 2005 to 2011 on a weekly basis. The non-linear nature of the price relationship is modelled by a panel four-regime error correction model. The analysis provides new evidence of significant time-variant wholesale to retail cost pass-through, which also might be interpreted as seasonal changing degrees of competition, pointing to seasonal fluctuations in cost pass-through as a common feature of commodity markets. In particular, costs are passed on to consumers more quickly during fall and winter and the effect of seasonally varying costs is dampened in higher markups.

Keywords:

Non-linear cost pass-through, seasonality, panel error correction model, milk

1 Introduction

The German retail market is characterized by highly price sensitive consumers with main dairy products as key items for their store choice. The dynamics of cost pass-through and its determinants, i.e. how cost shocks are passed on to retail shelves, are not only important to consumers and retailers, but also to dairy farmers and state agencies. This became especially apparent when prices rose rapidly for food manufacturers in 2001 and in 2007/2008. Economic explanations for delays in wholesale to retail cost pass-through are typically centered on models of imperfect competition (TIROLE 1988; BORENSTEIN et al. 1997; GOPINATH et al. 2011), menu costs (LEVY et al. 1997; DUTTA et al. 1999) and consumer search cost (TAPPATA 2009; YANG and YE 2008; CABRAL and FISHMAN 2012).

Asymmetric cost pass-through, also known as 'rockets and feathers' phenomenon (TAPPATA 2009), has been extensively documented in the empirical literature for consumer goods (PELTZMAN 2000; BAUMGARTNER et al. 2009; DUTTA et al. 2002; KINNUCAN and FORKER (1987); MILLER and HAYENGA 2001). Previous economic literature has addressed asymmetric cost pass-through with dynamic price reactions in terms of speed of adjustment towards the long-run price equilibrium allowing for endogenously determined regimes regarding the size of the deviation (LOY et al. 2014; RICHARDS et al. 2014; SERRA and GOODWIN 2003; BAULCH 1997).

However, little attention has been given to seasonality in price transmission. A few exemptions are OWYANG and VERMANN'S (2014) study of the U.S. gasoline market, BITTMANN and ANDERS'S (2016) cost pass-through analysis of the Canadian apple market, MACHADO and MARGARIDO'S (2001) analysis of international market integration, and GARDNER and BROOKS' (1994) and AMIKUZUNO and VON CRAMON-TAUBADEL'S (2012) study of regional market integration. This is surprising because seasonal fluctuations are a common feature of commodity markets, representing an exogenously triggered event and therefore a regime shift that retailers are equally exposed to. This raises the question of whether seasonal fluctuating input costs matter to cost pass-through in general and how they translate to different market structures and product categories.

The objective of this paper is to answer these questions by estimating the extent of seasonality in wholesale cost pass-through for the German milk market. The analysis employs disaggregated weekly store-level retail scanner data and wholesale prices for major German retail chains from 2005 to 2011 on a weekly basis, including different brands and retail formats.

The non-linear nature of the price relationship is modelled by a panel four-regime error correction model, which allows us to measure seasonal changing pass-through rates explicitly. The paper is organized as follows. In section 2 we give some theoretical background and introduce a simple model, followed by a short overview of the data and the methodological framework in section 3. In section 4 we discuss the results and finally conclude.

2 Theory

Price stability contributes an important factor to price formation in (food) markets in explaining links between consumer's utility functions, firm's production functions and fiscal policy (TAYLOR 1999). In a framework of costly price adjustments, time-dependent and state-dependent rules are considered for modelling firms' price-setting behavior. While time-dependent rules (CALVO 1983) predict price changes within a constant interval, state-dependent rules (CECCHETTI 1986; DOTSEY and WOLMAN 1999) predict price changes resulting from exogenous shocks, i.e. when the benefits of changing prices overweigh their costs. In particular, a state-dependent modelling scheme commonly assumes fixed costs of price adjustment and price changes as endogenous to the firm's profit maximization problem (SHESHINSKI and WEISS 1977) generating complex pass-through dynamics. While empirical findings in EICHENBAUM et al. (2011) support state-dependent rules, APEL et al. (2005) find evidence for time-dependent and state-dependent rules, which are triggered from extraordinary events. They suggest a mixture of both: firms review prices quarterly (or more often) and will deviate from time-dependent pricing when shocks are sufficiently large. Thus, the exact determination of costs related to price adjustments becomes crucial. Menu costs include labor costs and costs for printing and delivering new prices, mistakes and in-store supervision (LEVY et al. 1997; DUTTA et al. 1999). In a broader sense, management costs associated with information processing imply that adjustment decisions are made for product categories and not for each particular product separately (APEL et al. 2005). This problem becomes nontrivial when optimal price setting takes retailer competition (VARIAN 1980; CHEVALIER et al. 2003), implicit contracts (OKUN 1981) and consumer search cost into account.

For simplicity, consider a retailer's marginal revenue and price for a representative good in logs with a constant downward sloping demand curve,[1]

$$p^r - MR = \frac{\varepsilon}{(\varepsilon-1)}. \tag{1}$$

Setting marginal revenue equal to marginal cost (wholesale price), the optimal margin equals Lerner's index of market power,

$$L = p^r - p^w\ . \tag{2}$$

Seasonality of commodity prices adds an important dimension to the retailers' optimization problem. We rewrite retail prices as a function of seasonal markup and seasonal changing input cost,

$$p^r(S,t) = L(S,t) + \ p^w(S,t) \tag{3}$$

with

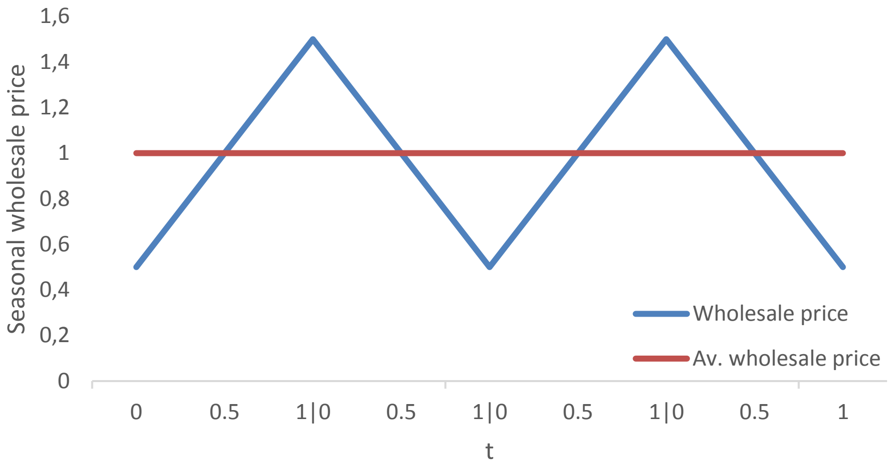
$$p^w(S,t) = p^{\bar{w}}[(2I_1 - 1)t + \tfrac{3}{2} - I_1], \tag{4}$$

where t denotes a continuous variable between zero and one indicating the time elapsed since the beginning of the current season. I_1 is a dummy variable which takes the value one if the

[1] The following argument is partly borrowed from business cycle theory as stated in BLINDER et al. (1998), who argue for counter-cyclical margins resulting from procyclical consumer elasticities. See further GARDNER (1975) and KINNUCAN and TADJION (2014) for a more in depth analysis.

system is in season one and zero if the system is in season two.[2] Starting from $p^{\overline{w}}/2$, wholesale prices increase during season one reaching their annual average value in the middle of the season ($t = 1/2$). At the end of season one wholesale prices are $p^{\overline{w}}/2$ above their annual average and decline during season two.[3]

Figure 1: Seasonal wholesale price and average annual wholesale price.



In absence of price adjustment costs, seasonality in wholesale prices are transmitted one to one to retailers shelve prices. We rewrite Lerner's Index in terms of retail price and seasonal components of wholesale cost,

$$L(S,t) = p^r(S,t) - p^{\overline{w}}[(2I_1 - 1)t + \tfrac{3}{2} - I_1]. \qquad (5)$$

In presence of price adjustment costs, as laid out above, retailers either adjust prices seasonally in order to maintain constant margins, hold retail prices constant resulting in counter-seasonal margins or construct an optimal policy of seasonal changing retail prices and margins. Higher margins increase the retailer's potential to deviate prices from marginal costs. Thus, seasonal changing marginal costs become more important for smaller margins or to put it differently, the effect of seasonality in wholesale prices decreases in margins. If seasonal varying input costs are an important factor for cost pass-through we would expect (i) pass-through estimates to differ significantly across seasons and (ii) the effect of seasonality to be dampened in higher markups.

We test these hypotheses by estimating seasonal cost pass-through including Lerner's Index[4], which also might be interpreted as a measure of seasonal competition.

3 Empirical model and data

The store-level retail data is composed of 2740 retail prices over a period of 364 weeks from 2005 to 2011. Wholesale prices cover the costs of production, packaging and transportation to the retailer and reflect buying prices of retailers.[5] Thirty-five percent of all price series are

[2] To facilitate the discussion we only consider two seasons. In the latter econometric analysis we use four indicator variables for spring, summer, fall, and winter season.

[3] This specification combines a state-based model with continuous adjustment within states and can easily be generalized by adding other seasons, scaling the seasonal effect or adding a time trend. See e. g. MEHREZ (1996).

[4] As noted, the relative margin can be interpreted as a Lerner index if the wholesale price represents all relevant variable costs.

[5] Retail prices are obtained from SymphonyIRI Group (SIG 2011), wholesale prices are obtained from an industrywide collection of dairy sales revenues conducted by the BMELV. Processing raw milk is highly

private label products. The average price for milk is 86.3 Eurocents per liter, the average wholesale price is 50.7 Eurocents per liter. Retail prices are more volatile than wholesale prices which stems from retailers' promotional activity. Retail prices and wholesale prices differ significantly across seasons, although differences are relatively small in economic terms. In spring, the peak of milk supply, prices are lowest. During summer prices increase, reaching their annual high in fall, followed by declining prices at the end of the year.

Table 1: Variable summary statistics

Variable	Definition	Mean	SD
$\boldsymbol{p^{r}}$	Retail price of milk	0.863	0.343
$\boldsymbol{p^{w}}$	Wholesale price milk	0.507	0.051
$\boldsymbol{p^{r,spring}}$	Retail price in spring	0.854	0.343
$\boldsymbol{p^{r,summer}}$	Retail price in summer	0.863	0.343
$\boldsymbol{p^{r,fall}}$	Retail price in fall	0.874	0.344
$\boldsymbol{p^{r,winter}}$	Retail price in winter	0.862	0.343
$\boldsymbol{p^{w,spring}}$	Wholesale price in spring	0.500	0.048
$\boldsymbol{p^{w,summer}}$	Wholesale price in summer	0.502	0.048
$\boldsymbol{p^{w,fall}}$	Wholesale price in fall	0.518	0.054
$\boldsymbol{p^{w,winter}}$	Wholesale price in winter	0.507	0.052

Source: Own calculations based on SIG (2011). Summary statistics of milk for major German retail chains with definition, mean and standard deviation. All retail and wholesale prices stated in Euro per Liter.

We assume that retail prices p_{it}^{r} are caused by wholesale prices p_{t}^{w} and define the error correction term ECT_{it} as deviation from the long-run relationship between the i^{th} retail and wholesale price series at time t.[6] Assuming that all panel members follow the same cost pass-through process with a common lag structure of order k for p_{i}^{r} and q for p^{w}, cointegration implies the existence of an error correction representation (ENGLE AND GRANGER 1987),

$$\Delta p_{it}^{r} = \delta ECT_{it-1} + \varphi \Delta p_{t}^{w} + \sum_{j=1}^{q-1} \beta_{j}^{w} \Delta p_{t-j}^{w} + \sum_{j=1}^{k} \beta_{j}^{r} \Delta p_{it-j}^{r} + \nu_{i} + e_{it}. \quad (6)$$

We control for fixed effects and augment the model with seasonal dummies and interactions terms allowing for seasonal changing long-term and short-term adjustments,

$$\Delta p_{it}^{r} = \sum_{S=1}^{3} d^{S} I_{t}^{S} + \sum_{S=1}^{4} \delta^{S} I_{t}^{S} ECT_{it-1} + \sum_{S=1}^{4} \varphi^{S} I_{t}^{S} \Delta p_{t}^{w} + \sum_{S=1}^{4} \sum_{j=1}^{q-1} \beta_{j}^{w,S} I_{t}^{S} \Delta p_{t-j}^{w} + \sum_{S=1}^{4} \sum_{j=1}^{k} \beta_{j}^{r,S} I_{t}^{S} \Delta p_{t-j}^{r} + \nu_{i} + e_{it}. \quad (7)$$

To test the second hypothesis of the dampening effect of higher margins the error correction term is multiplied with Lerner's Index L_{it} and added to the model specification,

$$\Delta p_{it}^{r} = \sum_{S=1}^{3} d^{S} I_{t}^{S} + \sum_{S=1}^{4} \delta^{S} I_{t}^{S} ECT_{it-1} + \sum_{S=1}^{4} \delta^{S,L} I_{t}^{S} L_{it} ECT_{it-1} + \sum_{S=1}^{4} \varphi^{S} I_{t}^{S} \Delta p_{t}^{w} + \sum_{S=1}^{4} \sum_{j=1}^{q-1} \beta_{j}^{w,S} I_{t}^{S} \Delta p_{t-j}^{w} + \sum_{S=1}^{4} \sum_{j=1}^{k} \beta_{j}^{r,S} I_{t}^{S} \Delta p_{t-j}^{r} + \nu_{i} + e_{it}. \quad (8)$$

The model allows the speed of returning to equilibrium to differ with respect to the sign and size of the deviation from the long-run equilibrium. This presents a statistically consistent specification of the theoretical model laid out above by distinguishing between state variables (seasons) not neglecting the dynamic nature of the price adjustment process. Higher seasonal adjustment coefficients in absolute terms imply that retail prices adjust faster when wholesale prices change compared to other seasons of the year.

4 Results

standardized, with negligible differences across firms and locations, which justifies using the same wholesale price for each retailer and each brand.

[6] In this framework pass-through is measured as the speed of adjustment at which retail prices move back toward the long-run equilibrium. Since we are interested in pass-through estimates we do not present estimates of short-term adjustments in the latter discussion.

We use average univariate Akaike Information Criteria (AIC) to determine a lag-length of $k = 4$ ($q = 6$) periods for p_i^r ($p^{\boldsymbol{w}}$). Bivariate Granger causality tests for each panel member suggest that wholesale prices are exogenous. According to panel unit-root tests (HADRI 2000) in levels and first differences the price series are integrated of order one. The four panel-cointegration tests by WESTERLUND (2007) reject the null of no panel-cointegration at 1% significance. Results of the two model specifications are summarized in Table 2.[7]

Table 2: Error correction estimates

	Δp_{it}^r (Eq. 7)	Δp_{it}^r (Eq. 8)
$\boldsymbol{\delta^{spring}}$	-0.124***	-0.228***
	(0.00321)	(0.00730)
$\boldsymbol{\delta^{summer}}$	-0.0716***	-0.154***
	(0.00247)	(0.00699)
$\boldsymbol{\delta^{fall}}$	-0.0977***	-0.152***
	(0.00250)	(0.00635)
$\boldsymbol{\delta^{winter}}$	-0.125***	-0.217***
	(0.00360)	(0.00800)
$\boldsymbol{\delta^{spring,L}}$		0.250***
		(0.0150)
$\boldsymbol{\delta^{summer,L}}$		0.197***
		(0.0137)
$\boldsymbol{\delta^{fall,L}}$		0.131***
		(0.0131)
$\boldsymbol{\delta^{winter,L}}$		0.239***
		(0.0162)

Source: Own calculations based on SIG (2011). Results of panel error correction estimates based on fixed effects. Robust standard errors reported in parenthesis. *** denotes 1% significance. δ^{Season}, seasonal adjustment; L_{it}, Lerner's index; $\delta^{\mathrm{Season,L}}$, seasonal interaction with Lerner's index.

We reject the hypothesis of no seasonality in cost pass-through at 1%. The results confirm that pass-through differs significantly across seasons. In spring, the season with lowest wholesale prices, pass-through is high, indicating a seasonal event of changing market conditions, already anticipated in comparable high winter pass-through rates. This points to the hypothesis that retailers cluster price adjustments seasonally. The coefficients for the relative margin show positive signs, indicating that cost pass-through slows down with market power, which is in line with findings in BORENSTEIN and SHEPARD (2002), RICHARDS et al. (2014), and LOY et al. (2014). Estimates differ significantly across seasons confirming the results in BITTMANN and ANDERS (2016), and AMIKUZUNO and VON CRAMON-TAUBADEL (2012), who emphasize the important role of time-variant market conditions in explaining variations in price transmission. The correspondence of higher seasonal pass-through rates in absolute terms with higher Lerner's index estimates is in line with theory in that higher markups dampen the seasonal effect.

5 Conclusions

Seasonal fluctuations in cost pass-through seem to be a common feature of commodity markets. The analysis employs disaggregate weekly store-level retail scanner data and wholesale prices for major German retail chains from 2005 to 2011 including different brands and retail formats. The non-linear nature of the price relationships is modelled by a panel four-regime error

[7] As promotional prices may influence estimated adjustment parameters (TIFAOUI and VON CRAMON-TAUBADEL 2016), seasonal promotional activity could in part drive our results. Therefore, we also estimated the model without promotional prices, which did not change the results.

correction model. Our results for the German dairy market show that costs are passed on to consumers more quickly during fall and winter and that the effect of seasonally varying costs is dampened in higher markups. This corresponds to the observation that regular customers are of great importance to retailers and frequently fluctuating prices could lead to a loss of consumer purchases and goodwill, which is in line with BLINDER et al. (1998) and APEL et al. (2005) who argue for implicit contracts as important factor of price rigidity. Cost pass-through decreases in margins also indicating that dairy products are used as loss leaders or to produce a 'halo' effect on the store's price image (LOY et al. 2014). The analysis faces some limitations. We used a simplistic theoretical framework. More detailed analysis should take into account other sources of price rigidities such as retailer competition, brand information, implicit contracts, and consumer search costs. Finally, possible seasonal asymmetries in pass-through were neglected in our analysis. The 'rockets and feathers' phenomenon may arise naturally by differences in costs associated with seasonal variations. Cost increases (decreases) that are triggered from non-seasonal events are amplified (dampened) during seasons of increasing costs. Vice versa, cost decreases (increases) that are triggered from non-seasonal events are amplified (dampened) during seasons of decreasing input costs. Future work should take these considerations into account and conduct more detailed analysis of differences in time-variant pass-through mechanisms and their respective determinants.

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