The impacts of cereal, soybean and rapeseed meal price shocks on pig and poultry feed prices

Abstract

The goal of this paper was to estimate how changes in the market prices of protein-rich and energy-rich crops impact the prices of pig and poultry feeds in Finland. A first-differenced AR1 model was estimated to explain how changes in soybean meal, wheat and rapeseed prices were transmitted to pig and poultry feed prices. Changes in cereal, soybean meal and rapeseed prices were transmitted to pig and poultry feed prices with a delay of 2 to 6 months. Cereal prices had a larger impact on feed prices than soybean meal prices.

Keywords: Price, volatility, feed, granivores, autoregressive model

1 Introduction

The volatility of agricultural commodity markets has increased in the recent years, and it may increase also in the future as public market interventions are gradually withdrawn and climate change increases the likelihood for adverse supply shocks in the sector. Volatility of prices has resulted in a number of analyses and policy recommendations. Wright (2011) reviewed a number of studies and concluded that recent price spikes are not as unusual as many discussions imply. Further, the balance between consumption, available supply, and stocks seemed to be as relevant for the understanding of these markets as it was decades ago. Though there is much to be learned about commodity markets, the tools at hand are capable of explaining the main forces at work, and of giving good guidance to policymakers confronted with a bewildering variety of expensive policy prescriptions (Wright 2011). More recently, Assefa et al. (2014) reviewed studies on price volatility transmission in vertical food markets. Their findings suggested that price volatility transmits along food supply chains thereby exposing all chain actors to risk and uncertainty.

Livestock markets are often criticized for price rigidity. As livestock production process takes time, it can be costly for producers to suspend production unless the animal stock is ready to be marketed. One of the implications is that if producers are faced by a strong market shock resulting in falling meat prices while input prices remain unchanged, may suffer large losses. It is therefore important for livestock producers to have information on how market prices behave and how risks related to volatile input and output priced could be mitigated.

In the pig and poultry sector feed price shocks are important, because feeds can represent over 60% of production costs of pig and poultry meat and eggs. It is therefore very important for pig and poultry farms to be able to control for the negative effects of feed price volatility. Increasing price volatility leads to increased market risk for farmers and can reduce their incentives to produce commodities. For instance, Rezitis and Stavropoulos (2009) examined the supply response of the Greek pork market and found that feed price is an important cost factor of the supply response function and that high uncertainty restricts the expansion of the pork sector.

Increasing price volatility can increase producer’s incentives to learn how prices behave and how the price risks could be managed. The transmission of price signals in the agricultural commodity markets, such as cereal markets, has been studied frequently (*e.g.* Liu, 2012; Gutierrez et al., 2014). However, very little is known about how market shocks in the cereal, soybean and other markets are transmitted to feed prices. One of the few studies is by Buguk et al. (2003) who investigated catfish feed markets and found a strong price volatility spillover from feeding material (corn, soybeans menhaden) to catfish feed and farm and wholesale-level catfish prices.

This paper focuses on the volatility and dynamics of feed prices. The aim was to estimate how changes in the prices of protein-rich and energy-rich crops impact pig and poultry feed prices. In addition, the goal was to discuss about feed price risk management implications.

2 Estimated model

Cereals (mainly barley and wheat), soybean meal and rapeseed are important sources of energy and protein in livestock feeds. Hence, their prices can have major impact on feed prices. Wheat price was used to indicate cereal prices because based on statistical testing, wheat price was a better indicator than barley price. Soybean meal, which is imported usually to Finland via Rotterdam or other major ports in Europe, and rapeseed meal prices were used to represent the prices of protein-rich feed ingredients, although rapeseed oil is also used as a source of energy in feeds.

The prices of feeds and feed ingredients correlate quite strongly and are likely to be non-stationary. Hence, a first-differenced AR1 model to explain monthly changes in pig and poultry feed prices with current and past changes in soybean mean, wheat and rapeseed prices was estimated. Without using the differenced form, there would have been a serious autocorrelation problem in the time-series model.

The following generic models were estimated for i) pig feed price and ii) poultry feed price.

$$P_t - P_{t-1} = \alpha + \sum_{i=1}^{6}\{\beta_i(S_{t-i} - S_{t-1-i}) + \gamma_i(W_{t-i} - W_{t-1-i}) + \delta_i(R_{t-i} - R_{t-1-i})\} \text{ for } t = 1, \dots, T,$$

where P_t is feed price index (pig feed or poultry feed), t is time index running from 1 to T time periods, α, β, λ and δ are parameters to be estimated, S_t is soybean meal price index, W_t is wheat price index, R_t is rapeseed price index and i is time lag considered. The feed industry in Finland is using market instruments such as futures contracts in the Chicago board of trade to protect their inputs costs for the next 3-6 months against major price shocks which may occur unexpected in the World markets. There may also be a delay between the purchase and use of inputs such as cereals or imported protein meals. Hence, price changes in the cereal and protein meal markets may impact feed prices with a delay.

The equations were estimated with Maximum likelihood method (see e.g. Hayashi, 2000) by using Matlab econometrics toolbox (LeSage, 2006).

3 Data

The data were obtained from on-line statistics. Soybean meal price (c.i.f. Rotterdam, beginning 1990) was obtained from the World Bank Commodity Price Data (The Pink Sheet) and converted to euros by using official currency exchange rates provided by the European Central Bank. Pig feed, poultry feed, wheat and rapeseed price indices were obtained from statistics Finland. All price indices were deflated to January 2014 by using consumer price index provided by Statistics Finland. Finally, all price indices were converted to an index so that January 2014 was represented by index value 1.

Figures 1 and 2 and Table 2 show that the prices of pig and poultry feeds, soybean meal, wheat and rapeseed correlate with each others. All correlations in table 2 are statistically significant at 5% risk level. Wheat price in particular tends to correlate quite strongly with other prices. This is unsurprising because crop prices are known to correlate and because cereals are an important part of pig and poultry diets. For instance, the correlation coefficient between wheat and rapeseed is 0.79. The correlation coefficients for both wheat and rapeseed prices with feed prices are higher than 0.5 whereas the correlation coefficients for soybean meal prices with feed prices are 0.42 and 0.29.

4 Results

The estimated models explained less than half of variation in feed prices. This implies that there is a lot of unexplained variation. In other words, in the short term other factors than only grain, soybean meal and rapeseed prices impact to the evolution of feed prices in Finland. However, when the models were applied for six successive months in order to forecast prices up to 6 months period in the future, as much as 75.8% of variation in poultry feed and 69.2% of variation in pig feed price could be explained by the models.

The results suggest that wheat prices observed 3-6 months earlier impacted the feed prices. However, for soybean meal price the lag was only 3-4 months and for rapeseed meal only 2-3 months (Table 3). For instance, when soybean meal price increased between time periods *t*-4 and *t*-3 by 10% (from January 2014 price level), this resulted in poultry feed price to increase by 1.14% and pig feed price by 1.04% between time periods *t*-1 and *t*. Furthermore, 10% increase in wheat price between *t*-6 and *t*-5 was associated with 2.21% increase in poultry feed price and 1.94% increase in pig feed price between periods *t*-1 and *t*. The impact of rapeseed price was of similar magnitude.

The data shows that although the standard deviations of soybean meal, wheat and rapeseed are 0.19, 0.9 and 0.23, their coefficients of variation are 27%, 20% and 24%, respectively. By contrast, the coefficients of variation were only 8% and 10% for poultry and pig feed prices. The variation of wheat and soybean meal prices are of the same magnitude but wheat price has larger coefficients estimated in the models than soybean meal price. Hence, the results suggest that the volatility of wheat price causes approximately twice as much variation in feed prices than the volatility of soybean meal price. In this respect it is more important to manage wheat than soybean meal price risk.

Based on the estimation data, the standard deviations of monthly changes in poultry and pig feed prices were 0.031 and 0.29 respectively. Corresponding standard deviations of fitted price changes were 0.020 (poultry feed) and 0.017 (pig feed), whereas the standard deviations of unexplained variation in monthly price changes (i.e. the model's residual) were 0.024 in both model. Hence, even if all variation in the feed prices were eliminated by reducing the volatility of wheat, soybean meal and rapeseed prices to zero, the price volatility of pig and poultry feeds could be reduced by less than 25 %.

5 Conclusion

The results suggest that changes in cereal, soybean meal and rapeseed prices are transmitted to pig and poultry feed prices with a delay of 2 to 6 months. Hence, livestock farm's production costs do not increase or decrease instantaneously even if cereal or soybean meal prices would increase or decrease rapidly. Moreover, changes in cereal prices have a larger impact on feed prices than changes in soybean meal prices. Because a lot of variation in prices remained unexplained, it is more efficient to be prepared for feed price risks than the price risks associated with individual components (such as cereals) used as to manufacture feeds. Overall variation in feed prices was smaller than the aggregate variation in prices of individual components (such as cereals) used as to manufacture feeds.

6 References

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7 Tables and figures

Table 1. Descriptive statistics of the data (2000-2014)[1].

	Mean	SD
Soybean mean price[2]	0.6854	0.1868
Pigfeed price	0.9794	0.0944
Poultry feed price	0.9917	0.0773
Wheat price	0.9276	0.1901
Rapeseed price	0.9259	0.2257

1) Source: Calculated based on data provided by Statistics Finland, except soybean meal price calculated based on the data obtained from the World Bank. All price indices are real prices (January 2014) represented in Euro terms and calculated to the reference January 2014=1.

2) Soybean meal (any origin), Argentine 45/46% extraction, c.i.f. Rotterdam.

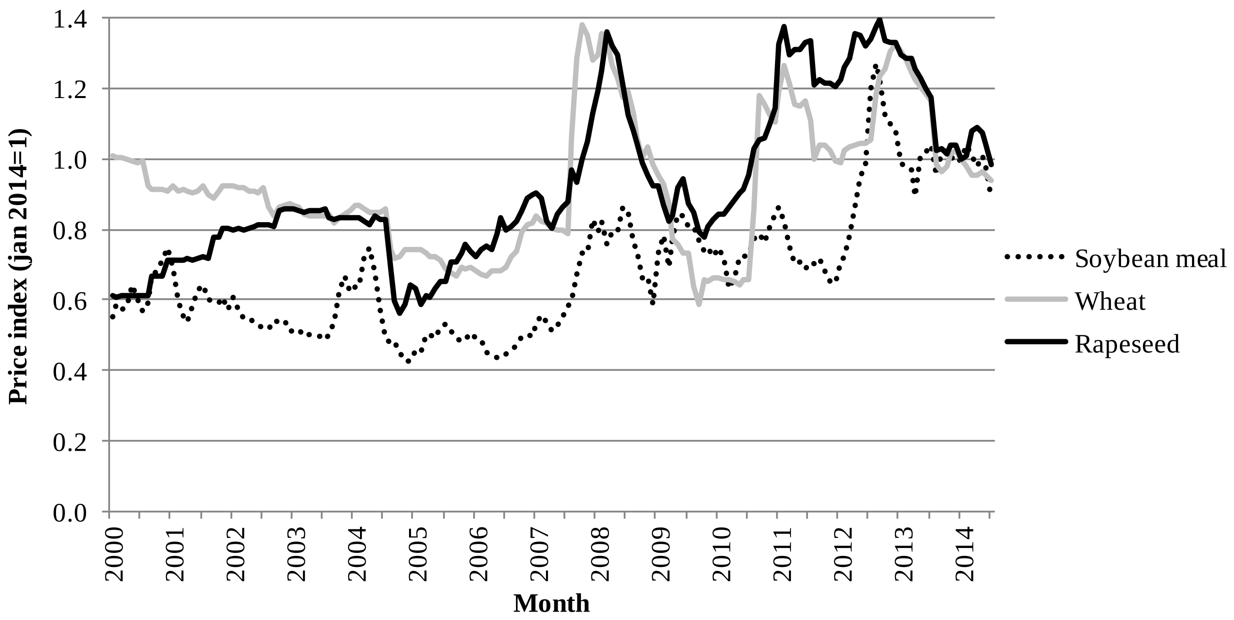

Figure 1. The development of wheat, rapeseed and soybean meal (CIF Rotterdam) prices in Finland (real prices deflated to January 2014 price level and transformed to an index where January 2014=1).

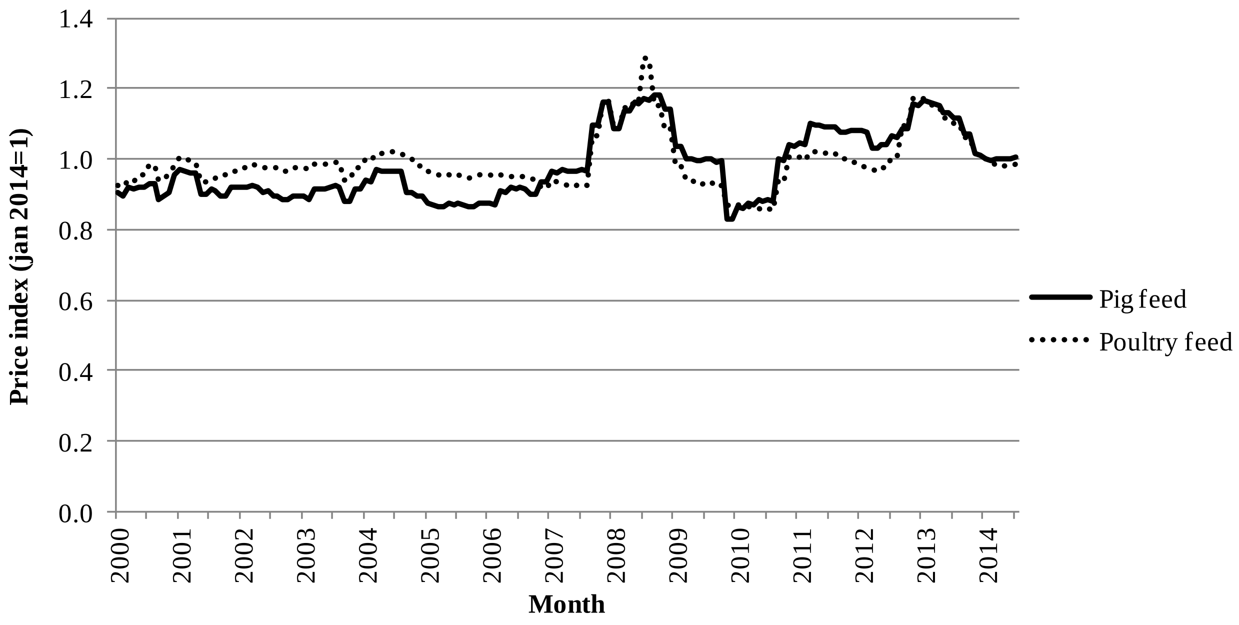

Figure 2. The development of feed prices in (real prices deflated to January 2014 price level and transformed to an index where January 2014=1).

Table 2. Correlation coefficients between deflated prices of pig and poultry feed, soybean meal, wheat and rapeseed, pigmeat, poultry meat and eggs.

	Pig feed	Poultry feed	Soybean meal	Wheat	Rapeseed	Pigmeat	Poultry meat	Eggs
Pig feed	1.00	0.96	0.42	0.73	0.67	0.63	0.67	0.66
Poultry feed	0.96	1.00	0.29	0.67	0.54	0.65	0.72	0.59
Soybean meal	0.42	0.29	1.00	0.60	0.71	0.38	0.36	0.68
Wheat	0.73	0.67	0.60	1.00	0.79	0.62	0.62	0.74
Rapeseed	0.67	0.54	0.71	0.79	1.00	0.45	0.49	0.73
Pigmeat	0.63	0.65	0.38	0.62	0.45	1.00	0.90	0.65
Poultry meat	0.67	0.72	0.36	0.62	0.49	0.90	1.00	0.75
Eggs	0.66	0.59	0.68	0.74	0.73	0.65	0.75	1.00

Table 3. Maximum likelihood ar1 serial correlation estimates.

Dependent variable[1)]	Poultry feed price$_{t\text{-}1 \rightarrow t}$		Pig feed price$_{t\text{-}1 \rightarrow t}$	
R-squared	0.422		0.334	
Log Likelihood	200.770		201.094	
Number of observations	169		169	
Variable[1)]	Coefficient	p-value	Coefficient	p-value
Rapeseed price$_{t\text{-}3 \rightarrow t\text{-}2}$	0.226	0.000	0.126	0.004
Soybean meal price$_{t\text{-}4 \rightarrow t\text{-}3}$	0.114	0.002	0.104	0.006
Wheat price$_{t\text{-}4 \rightarrow t\text{-}3}$	ns	ns	0.074	0.024
Wheat price$_{t\text{-}6 \rightarrow t\text{-}5}$	0.221	0.000	0.194	0.000

1) Subscripts *t*-2, *t*-3, *t*-4, *t*-5 and *t*-6 refer to time periods before month *t*, and ➔ refers to the change of price between the two time periods.
ns=not significant at 5% risk level.