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Are piglet prices rational hog price forecasts?

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Abstract

In this paper a simple model is developed in which the piglet price serves as a forecast for the hog price 3 months ahead. The model is tested on data from Northern Europe, viz. Norway, Sweden, Denmark and Finland during the period 1982–1992. The empirical results lend strong support to the hypothesis that hog producers hold rational expectations when pricing the piglets. Thus, the weight adjusted piglet price typically represents an unbiased (conditional) forecast with unsystematic errors for the hog price one quarter later.

1. Introduction

Piglet prices should embody information about hog prices 3 months into the future. The purpose of this paper is to specify a simple procedure to test whether piglet prices are rational forecasts of subsequent hog prices, i.e. forecasts that are unbiased with unsystematic errors. Such a test is obviously of great practical relevance. If piglets are priced rationally, hog price forecasts are easily available. If hog producers do not hold rational expectations, there should be room for profitable speculation in trading piglets or in offering forward hog prices that are fixed some way or another to the piglet price.

In this paper, we present a simple model in which the hog price one quarter into the future is estimated as a function of today's weight adjusted piglet price and today's expected feed costs and expected profits. The model is tested on three sub-samples based on monthly price observations 1982–1992 from each of the Nordic countries (Norway, Sweden, Finland and Denmark).

2. Intertemporal price relationships in the hog business

The farrowing decision made by the piglet producer (timing and numbers) should be influenced by his expectations as to what price he will get for his piglets some 25 weeks later and by his expected feeding costs during this time span. However, as he knows that the future piglet price will depend on the buyer's expectations of what the latter will get paid for his hogs another 3–4 months later, the rational piglet producer should make his farrowing decision based upon his expectations for the hog price some 9–10 months later.

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Once farrowing has taken place, the subsequent supply of pork is more or less fixed (disregarding the possibility of imports or exports and also the variations in slaughter weight). Hence, both the supply of piglets and the supply of pork are highly inelastic in the short run. Considering the intertemporal sequence of supply and demand decisions, the price that clears the piglet market should represent a forecast of the hog price, conditional on the expected feed costs over the subsequent 2–3 months. However, since piglets and hogs are qualitatively different entities, the piglet price cannot be used outright as a hog price forecast. Consequently, for forecasting purposes, the piglet price should be adjusted in a way that reflects the proportional weight of the piglet costs.

The problem caused by the producer's need to forecast two prices simultaneously, (i.e. the hog price and the feed price), may be handled by focusing on the expected profit, i.e. the expected difference between product price and aggregated input costs. Thus, rational expectations should yield piglet prices that are unbiased forecasts of the subsequent margins, with unsystematic errors. Abstracting from capital and labor costs, the hog producer's profit is

$$\Pi = P^{\mathrm{H}} w^{\mathrm{H}} - P^{\mathrm{F}} w^{\mathrm{H}} \psi - P^{\mathrm{P}} w^{\mathrm{P}} \tag{1}$$

where P^{H} is the price per kilo pork; P^{P} is the price per kilo at which the piglet was bought, whereas P^{F} is the average price per kilo feed during the feeding period. w^{H} and w^{P} are the weight of hogs (slaughtered) and piglets, respectively and ψ is the feed conversion factor (feed per kilo pork). Profit per kilo finished product, $\pi = \Pi / w^{\mathrm{H}}$, is thus given by

$$\pi = P^{\mathrm{H}} - P^{\mathrm{F}} \psi - P^{\mathrm{P}} (w^{\mathrm{P}} / w^{\mathrm{H}}) \tag{2}$$

Letting $t-1$ denote the time when the piglets are bought and t the time when the hogs are slaughtered with approximately 3 months between t and $t-1$, the expected profit per kilo is given by

$$E_{t-1}(\pi_t) = E_{t-1}(P_t^{\mathrm{H}}) - E_{t-1}(\bar{P}_t^{\mathrm{F}}) - \bar{P}_{t-1}^{\mathrm{P}} + \mu_t \tag{3}$$

where

$$\bar{P}_t^{\mathrm{F}} = \psi P_t^{\mathrm{F}}$$

and

$$\bar{P}_{t-1}^{\mathrm{P}} = (w^{\mathrm{P}} / w^{\mathrm{H}}) P_{t-1}^{\mathrm{P}}$$

and μ_t is an error term. Hence,

$$E_{t-1}(P_t^{\mathrm{H}}) = E_{t-1}(\pi_t) + E_{t-1}(\bar{P}_t^{\mathrm{F}}) + \bar{P}_{t-1}^{\mathrm{P}} + \mu_t \tag{4}$$

Since expected profits and expected feed costs normally are unobservable, these variables will have to be modeled. A common procedure to obtain such data, is to estimate the unknown variables as autoregressions of the observed values or simply to use the observed lagged values as instrumental variables (see Wickens, 1982, for a further discussion). This will be the approach in our empirical analysis. Thus, we specify the time series for the profit and feed costs as first-order autoregressions, i.e.

$$E_{t-1}(\bar{P}_t^{\mathrm{F}}) = \lambda_0 + \lambda_1 \bar{P}_{t-1}^{\mathrm{F}} + \varepsilon_{1,t} \tag{5}$$

and

$$E_{t-1}(\pi_t) = \delta_0 + \delta_1 \pi_{t-1} + \varepsilon_{2,t} \tag{6}$$

with error terms that are assumed to be unsystematic.

Given rational expectations, Eq. (4) can then be written as

$$E_{t-1}(P_t^{\mathrm{H}}) = \beta_1 \bar{P}_{t-1}^{\mathrm{P}} + \beta_2 E_{t-1}(\bar{P}_t^{\mathrm{F}}) + \beta_3 E_{t-1}(\pi_t) + \mu_t \tag{7}$$

where $\beta_1 = \beta_2 = \beta_3 = 1$ and $\mu_t \sim IN(0, \sigma^2)$.

Assuming that the expected profit and feed costs can be described as a first-order autoregressive process as in Eqs. (5) and (6), Eq. (7) can be estimated as

$$P_t^{\mathrm{H}} = A + \beta_1 \bar{P}_{t-1}^{\mathrm{P}} + \vartheta \bar{P}_{t-1}^{\mathrm{F}} + \phi \pi_{t-1} + \xi_t \tag{8}$$

where A is $\beta_2 \lambda_0 + \beta_3 \delta_0$; ϑ is $\beta_2 \lambda_1$; ϕ is $\beta_3 \delta_1$; ξ_t is $\mu_t + \beta_2 \varepsilon_{1t} + \beta_3 \varepsilon_{2t} \sim IN(0, \sigma^2)$.

Alternatively, one can estimate

$$P_t^{\mathrm{H}} = \alpha + \beta_1 \bar{P}_{t-1}^{\mathrm{P}} + \beta_2 (\bar{P}_t^{*\mathrm{F}}) + \beta_3 (\pi_t^*) + \mu_t \tag{9}$$

where * indicates that the values for expected feed prices and profits are the predictions obtained through Eqs. (5) and (6). Estimating Eq. (9), i.e. using the predicted values for expected profits and feed prices as instruments, gives us directly parameters that enable us to test the rationality hypothesis ($\beta_i = 1$).

3. Empirical results

The model above was estimated utilizing monthly price observations from the Nordic countries, viz. Norway, Sweden, Denmark and Finland over the period 1982–1992. Despite these countries' quite different institutional characteristics as far as agricultural policy is concerned, the price variability in the piglet and hog markets has been of practically the same magnitude in all four countries. For the entire period, the monthly SD of absolute prices have been approximately 10–18% of mean absolute prices. The annualized SD of the monthly percent price changes has been around 10–14%. As to the variability in relative price changes, Finland makes an exception with a SD of 4–5%.

Utilizing monthly observations for testing a 3 month forecast creates the well known overlapping observation problem, causing serially correlated forecast errors. Thus, when the forecasting period extends beyond the observation frequency, the forecast error will follow a moving average process of degree ($k - 1$), where k is the number of overlapping periods (Frenkel, 1980). Various ways have been suggested to get around this problem (see, for instance, Sargent, 1979; Hansen and Hodrick, 1980). The simplest solution is, of course, to avoid using overlapping observations. In our case, this would imply using observations from every third month only, the disadvantage being that we may lose relevant information from the intermediate 2 months and hence get large sampling errors. In order to reduce this disadvantage, we have divided the series of monthly observations into three sub-samples of 3-monthly observations and then estimated on the basis of each sub-sample. Consequently, we have tested for rational expectations during the period February 1982–December 1992 for the four Nordic countries using three sets of non-overlapping observations for each country. Data set A includes observations from January, April, July and October, data set B from February, May, August and November, while set C covers the months March, June, September and December.

We have assumed a feed conversion factor (ψ) of 3.0 throughout the period in question, whereas the piglet/hog weight ratio is set at 0.33. (The feed conversion factor is calculated as the amount of feed consumed from the time the piglets are bought divided by the slaughter weight. A feed conversion factor of 3.0 is a rough approximation for these countries during the period in question. A piglet/hog weight ratio of 0.33 reflects the fact that piglets in these countries are typically 22–25 kilos, whereas the slaughter weights are normally 66–75 kilos.) Changing these constants does not have any significant effect on our conclusions. However, any follow-up study to the present paper might consider a more elaborate treatment of these two factors, as both to some extent may be endogenously influenced by expectations.

On a few occasions, minor changes in definitions have occurred as to the way price data have been registered. We have used dummies to correct for this. However, since the resulting jumps were both small and infrequent, the inclusion of dummies did not make much difference to the estimation results.

Our assumption that feed costs and profits follow a first-order autoregressive AR(1) pattern is obviously crucial for the tests. Estimating Eq. (5), it was found that feed costs in all samples and countries are very well described by an AR(1) process. A substantial part of the variance was explained and the errors did not appear to be serially correlated. In the case of Norway and Finland, also the profits series were found to follow an AR(1) process. The first-order parameter was found to be significant in a majority of the samples. Still, the explained variance in the profit series through estimation of Eq. (6) was modest for both countries. For Sweden and Denmark, however, the quarterly profit observations seem to follow a less simplistic process. The latter fact should be kept in mind when interpreting the results from testing the model in which, despite the mixed results for Sweden and Denmark, we utilize the autoregressively predicted profits and feed prices as proxies for their expected values.

The results from estimating Eq. (9) reported in Table 1 lend strong support to the rational expectation hypothesis. With just a few exceptions, the estimated βs do not differ significantly from unity, and the error terms seem to be unsystematic. The results regarding the forecasting abilities of the (weight adjusted) piglet price are particularly strong. Except for two samples (Sweden in data set C and Finland in data set A), the estimated piglet price parameter does not differ significantly from unity. In many cases, the estimated values are very close to unity, indeed. Actually, it is for Denmark that we find the largest numerical deviations from 1.0. Still, the rational expectations hypothesis is accepted also in the Danish samples. For Denmark, and in some cases also in the other countries, the feed parameter, however, differs significantly from unity. It is reason to believe that this may be due to our use of simple autoregressive forecasts as instrumental variables for expected feed costs and profits.

Beyond supporting the hypothesis that piglet prices tend to be unbiased forecasts, our simple model predicts remarkably well the hog price 3 months into the future, again with some modifications for Denmark. Whereas the explained variance for the latter ranges from 0.58 to 0.69, the three other countries have adj. R^2s between 0.85 and 0.96!

Table 1
Testing for rational expectations, OLS-estimation of $P_t^{\mathrm{H}} = \alpha + \beta_1 \bar{P}_{t-1}^{\mathrm{P}} + \beta_2(\bar{P}_t^{*\mathrm{F}}) + \beta_3(\pi_t^*) + \mu_t$

Data set	α	β_1	β_2	β_3	t-value $\mathrm{H}_0: \beta_1 = 1$	t-value $\mathrm{H}_0: \beta_2 = 1$	t-value $\mathrm{H}_0: \beta_3 = 1$	DW	adj.R^2
Norway									
A	−484.4	0.95	1.64	0.91	−0.36	1.62	−1.31	2.08	0.96
	(−1.60)	(6.60)	(4.15)	(13.18)					
B	−663.0	0.98	1.76	0.96	−0.10	1.63	−0.50	1.95	0.95
	(−1.86)	(6.00)	(3.77)	(11.37)					
C	−655.4	0.93	1.87	0.88	−0.35	1.56	−1.31	2.00	0.93
	(−1.60)	(4.55)	(3.36)	(9.69)					
Sweden									
A	−29.9	0.95	1.09	1.11	−0.56	0.41	0.24	1.77	0.88
	(−0.23)	(9.93)	(5.05)	(2.39)					
B	−88.5	0.92	1.21	1.15	−0.93	1.04	0.24	1.90	0.90
	(−0.62)	(10.14)	(5.90)	(1.85)					
C	−164.2	0.78	1.47	1.30	−2.05 *	1.93	0.40	1.66	0.85
	(−0.97)	(7.27)	(6.06)	(1.76)					
Denmark									
A	−386.3	0.55	1.98	1.48	−1.61	2.90 *	0.60	1.95	0.58
	(−1.83)	(1.96)	(5.85)	(1.82)					
B	−416.6	0.66	2.21	0.80	−1.41	3.74 *	−0.45	2.02	0.69
	(−2.24)	(2.70)	(6.82)	(1.80)					
C	−326.9	0.57	2.04	1.00	−1.58	2.81 *	0.01	2.13	0.65
	(−1.54)	(2.10)	(5.50)	(2.15)					
Finland									
A	−106.1	0.81	1.49	1.02	−2.73 *	2.39 *	0.11	2.37	0.95
	(−1.11)	(11.98)	(7.28)	(6.37)					
B	−59.1	0.89	1.23	1.09	−1.28	0.82	0.50	2.46	0.92
	(−0.49)	(10.02)	(4.37)	(6.18)					
C	−107.4	0.87	1.30	1.16	−1.65	1.19	0.89	2.25	0.93
	(−0.90)	(11.39)	(5.16)	(6.44)					

() represent t-values, $\mathrm{H}_0: \beta_i = 0$; * significantly different from unity at 5% level; $n = 43$.

4. Conclusions

The markets for piglets and hogs are in general quite volatile. The Nordic markets make no exception.

Our statistical results support the hypothesis that the Nordic hog producers price the piglets rationally in the sense that the weight adjusted piglet price may serve as an unbiased forecast for the hog price 3 months ahead, conditional on the expected feed costs and profits. Furthermore, the forecast errors seem to be unsystematic.

Our conclusion must be somewhat modified in the case of Denmark. Although the piglet prices also in the Danish samples were found to be unbiased, the model did not perform as well as for the neighbouring countries. This may, of course, indicate that the producers in the highly competitive Danish market are less rational than their Nordic neighbours. An alternative, and more plausible explanation, is that in the case of Denmark, our model is not well specified. As mentioned above, modeling expected feed costs and profits as simple AR(1) processes may be too simplistic in the Danish case. Despite this modification, based on the Nordic data, piglet prices seem to be remarkably good forecasts for hog prices one quarter ahead.

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The complete data set is available from the author upon request together with information about sources and variable definitions.

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