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Do Livestock Futures Prices React Efficiently to USDA Hogs and Pigs Reports

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Phil L. Colling Scott H. Irwin Carl R. Zulauf*

Following the release of a USDA inventory report, agricultural economists often term the report as "bullish, bearish, or neutral," referring to the anticipated effect that the report will have on prices. The classification is based on the difference between the mean of expert's observed expectations (sometimes called "pre-release estimates") and the values given in the report. The notion stems from the efficient market hypothesis (Fama) which states that prices reflect all known information. Therefore, prices should respond to new information only to the extent to which it is unanticipated.

Agricultural Economists have extensively examined the effects of major information on prices. Barnhart (1988, 1989) examined the effects of macroeconomic announcements on several futures prices. Previous studies have examined the effects of USDA Crop Production reports on cash and futures prices for grains (Gorham; Fackler; Milanos; Sumner and Mueller). The USDA Cattle of Feed report has been investigated to determine its effect on cash and futures prices for cattle (Hoffman). The effects of the Hogs and Pigs report on hog prices has also been examined (USDA, 1977; Miller; Hudson, Koontz and Purcell; Carter and Galopin; Colling and Irwin). Schroeder, Blair and Mintert examined the effects of USDA Cattle on Feed and Hogs and Pigs reports on live-cattle, feeder-cattle and live-hog futures prices.

The study of Colling and Irwin is unique in that survey data were used to serve as a proxy of market expectations, allowing the unanticipated component of information to be distinguished. They examined only the efficiency of live-hog futures price reactions to the Hogs and Pigs report (HPR). However, other livestock futures contracts should also be affected by the HPR. For example, pork belly supplies are directly affected by hog supplies suggesting that pork-belly futures prices should respond the HPR. In addition, since pork and beef are substitute products, live-cattle and feeder-cattle futures prices should be affected by the HPR. This study examines the effects of HPRs on prices of live-hog, pork-belly, live-cattle and feeder-cattle futures contracts traded at the Chicago Mercantile Exchange.

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DATA

For all livestock futures contracts, futures prices collected include closing prices on the days the HPR was released, as well as opening and closing futures prices for five trading days following the HPR release. Various "time-horizons" of futures contracts are defined corresponding to the approximate number of months from the time the HPR is released until the futures contracts expire. This procedure allows the effects of different information on futures contracts with different lengths of time to expiration to be determined.

As a proxy for market expectations of reported changes in breeding and market hog inventories from year-ago levels, an average of market analysts' expectations is incorporated. The survey data are collected by Futures World News and released over electronic news services two trading days prior to the release of the HPR and after the close of trade of the livestock futures contracts on that day. The survey data have been shown to conform almost entirely to Muth's rational expectations hypothesis, suggesting that they are a reasonable proxy of market expectations (Colling, Irwin, and Zulauf). Actual changes in breeding and market hog inventories are given the quarterly USDA Hogs and Pigs report. The sample runs from the September 1981 through the June 1990 HPR, providing thirty-six observations.

PROCEDURES AND RESULTS

Under the efficient market hypothesis, a price should reflect all available information relevant to the formation of that price. Therefore, price changes following releases of HPRs should not be a function of anticipated information. This is because the anticipated information is known information. To test the hypothesis that anticipated information has no effect on price changes after the HPRs are released, the following models are estimated for each time-horizon and for all commodity contracts:

$$(1)\ \mathrm{Ln}(FP_t^i(O^1)) - \mathrm{Ln}(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t^e) + \beta_2(MKT_t^e) + \mu_t$$

where Ln denotes the natural logarithm, FP_t^i denotes the futures price for commodity i and HPR t, C denotes close of trade, O denotes open of trade, a superscript 0 denotes the day of an HPR release and a superscript 1 denotes the day following an HPR. That is, the price change is from the close of trade on the day of the HPR to the open of trade the following day, making the price change an "immediate" price change. The dependent variable is specified as differences in natural logs because futures prices are generally believed to follow a geometric random walk. BRD and MKT refer to breeding and market hogs, respectively, and a superscript e denotes expectations, as proxied by the mean of the survey data. Because of the institutional limit structure of prices at the Chicago Mercantile Exchange, in which livestock futures prices are allowed to move by no more than $1.50/cwt. ($2.00/cwt. for pork-bellies) during a trading day from the previous day's closing price, the two-limit tobit model is used for all estimations (Rosett and Nelson; Madalla). None of the coefficient estimates from the above model for any contracts are different from zero suggesting that prices do not respond to expected information. These results suggest that the anticipated information is reflected in prices.

Under the efficient market hypothesis, prices should adjust to new unanticipated information instantaneously. In addition, price patterns following the immediate price following the HPR should not be predictable. Such an occurrence might indicate that profitable trading strategies are possible. Ideally, this could be tested by regressing changes in prices for selected times following the HPR on unanticipated breeding and market hog information. However, given the institutional price limits of the Chicago Mercantile Exchange, this would not be appropriate because prices, by their limited nature, tend to move away from their closing level on the day of the HPR. To test for the reaction of futures prices to unanticipated information, and for predictable price patterns, the following cumulative price-change models are estimated:

$$(2;\ O1)\quad \ln(FP_t^i(O^1)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t.$$
$$(3;\ C1)\quad \ln(FP_t^i(C^1)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(4;\ O2)\quad \ln(FP_t^i(O^2)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(5;\ C2)\quad \ln(FP_t^i(C^2)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(6;\ O3)\quad \ln(FP_t^i(O^3)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(7;\ C3)\quad \ln(FP_t^i(C^3)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(8;\ O4)\quad \ln(FP_t^i(O^4)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(9;\ C4)\quad \ln(FP_t^i(C^4)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(10;\ O5)\quad \ln(FP_t^i(O^5)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t,$$
$$(11;\ C5)\quad \ln(FP_t^i(C^5)) - \ln(FP_t^i(C^0)) = \beta_0 + \beta_1(BRD_t - BRD_t^e) + \beta_2(MKT_t - MKT_t^e) + \mu_t$$

where all terms are as defined earlier, the superscripted number refers to the number of days following the HPR, and O denotes open of trade and C denotes close of trade. The letter following the equation number refers to open (O) or close (C) of trade while the number refers to the number of trading days following the HPR. For example, O4 denotes the open of trade four days following the HPR. Note that model 2 is identical to model 1 except that unexpected information (the difference between actual and expected information) is substituted for expected information in the explanatory variables. The following models (3 through 11) increment the length of time for the price change from the open of trade on day 1, to the close of trade on day 1, then to the open of trade on day 2, and so on. The notion behind this procedure is to obtain estimates for <u>cumulative</u> price changes. Again, the two-limit tobit model is used to account for price limits.

Coefficient estimates and summary statistics for the immediate price change model (2) appear in Table 1. The coefficient estimates are interpreted as the percentage change in price for each percent of a bearish forecast error. The absolute values of the coefficient estimates are largest for the live hog and pork belly contracts. Although live cattle and feeder cattle respond to unanticipated information, the coefficients are not nearly as high. This result is consistent with theory because cattle prices should only be indirectly affected by hog supplies.

To test the null hypothesis that prices do not change following their immediate response, the slope coefficient estimates for models 3 - 11 are jointly restricted to those from models 2 - 10, respectively. These results are presented in Table 2. Many of the likelihood ratio statistics reject the null hypothesis, suggesting that some price patterns following the HPR do exist. However, many of the likelihood ratio statistics are not different from zero.

Slope coefficient estimates for all time-horizons and all price change models (2-11) with respect to live-hog futures prices appear in Figure 1. The price change model is indicated on the horizontal axes, again where the first letter indicates open or close of trade and where the number indicates the number of trading days following the HPR. A dark or closed circle indicates that the parameter estimate is significantly different from zero at the five-percent level while an open circle indicates that the coefficient estimate is not different from zero at the five percent level. Again, the slope parameter estimates are interpreted as the percent change in price given a one-percent bearish forecast error.

All slope parameter estimates for breeding and market hogs for the immediate (O1) model are significantly different from zero at least at the five-percent level. As expected, parameter estimates for the more nearby time-horizon contracts (time-horizons 1-2 (months) and 2-3) are greater for unanticipated market hog inventories while parameter estimates for breeding hog inventories are greater for the more distant time-horizon contracts (time-horizons 7-8 and 10-11). This reflects the fact that market hogs will be ready for market in the near term while the potential pig crop from breeding hogs will not be on the market for at least one hog-production period (about nine months). These results are consistent with those of Colling and Irwin.

For breeding hog inventories, coefficient estimates remain approximately the same for all models for time-horizons 1-2 and 2-3 months. However, time-horizons 4-5 and 7-8 contracts appear to overreact initially to breeding hog information in that the initial coefficients are quite large (in absolute terms) but become smaller as time passes following the HPR. For example, the parameter estimate for the open of day 1 (O1) for time-horizon 4-5 months is approximately -1.4, but the parameter estimate moves back to about -0.7 by the close of trade three days following the HPR. For time-horizon 7-8 months, the parameter estimate begins at about -1.4, and actually moves closer to -1.5 by the close of trade one day following the HPR, and then reverts to -1.1 two days following the HPR. The time-horizon 10-11 contract does not appear to display any pattern of adjustment to breeding hog inventories.

All market hog coefficient estimates appear to overreact to some degree. This is especially true for time-horizons 4-5, 7-8 and 10-11 months. For example, the parameter estimate for time-horizon 4-5 months begins at about -1.5, and is significantly different from zero, but reverts back to about -0.8 by the close of trade one day following the HPR, and is then not significantly different from zero. Similar patterns exist for time-horizons 7-8 and 10-11 months. These results suggest that the last three time-horizons overreact to the unanticipated market hog information.

Pork-belly futures contract prices are also very responsive to unanticipated information in the HPR (see Figure 2). All immediate parameter estimates (O1) for unanticipated breeding hog inventories are roughly -1.3 for all time horizons. By the close of trade one day following the HPR, all of the coefficient estimates move to roughly -2.0, but move back to -1.3 by the open of trade on day two. This suggests that the market reacts initially, and then reacts further to unanticipated breeding hog information, and then reverts back. All parameter estimates are different from zero suggesting that breeding hog information is very important.

Market hog information also impacts pork-belly prices. Estimates for time-horizon 2-5 months begin at around -1.6 (01) and remain at about that level until the open of trade three days following the HPR. At that point, the parameter estimate reverts to roughly -1.1 and stays at about that level for the remainder of the study period. Market hog coefficient estimates for time-horizon 5-8 months contracts display behavior similar to that of breeding hog coefficients in that they react, then appear to overreact, and then revert back to their original value. Time-horizon 8-11 months contracts begin at about -1.1 and do not move substantially from that level during the study period. This suggests that the market hog information is interpreted rather quickly in those contracts. Most coefficients are different from zero, suggesting that market hog information is important to the pork-belly market. In addition, a higher proportion of the coefficients are significant than those for live-hogs, suggesting that market hog information is more important to the pork-belly futures market than to the live-hog futures markets.

In comparing Figure 1 (pork-belly futures) to Figure 2 (live-hog futures), it is seen that the coefficient estimates are greater for the pork-belly futures contracts. In addition, for pork-belly futures, the coefficient estimates settle at around -1.0 for both breeding and market coefficients and for all time-horizons. This suggests that pork-belly futures do not distinguish between breeding and market hog information whereas the live-hog futures do distinguish between the different information.

Live-cattle futures prices are also immediately responsive to unanticipated breeding and market hog inventory changes (Figure 3). Time-horizons 1-2 and 2-3 months respond initially to breeding hog information in the HPR with parameter estimates of roughly -0.2. By the close of trade one day following the HPR, the coefficient estimates move toward zero and become non-significant. The time-horizon 4-5 months contracts also respond initially to the breeding hog information. By the open of trade three days following the HPR, none of the coefficient estimates remain significant. A similar story applies to time-horizon 6-7 months, but coefficient estimates do not become insignificant until the close of trade four days following the HPR. Time-horizon 8-9 months and 10-11 months contracts also respond initially to the HPR and most of the coefficient estimates are significantly different from zero. Still, there is a tendency for the coefficients to move toward zero. Although most of the market hog parameter estimates are significantly different from zero for the immediate model (01), they become non significant by the close of trade on day one. This evidence suggests that those contracts might overreact to the information or that random information enters the market and the HPR information becomes less important as time passes.

Generally, the coefficient estimates for the live-cattle futures contracts are quite small when compared to those for live-hog and pork-belly contracts. For example, none of the coefficient estimates are greater than 0.5 (in absolute terms) for live-cattle futures. However, almost all of the pork-belly coefficient estimates are greater than 1.0. Most parameter estimates for live-hog contracts are greater than 0.5, and some greater than 1.0, again in absolute terms. This suggests that live-cattle futures prices are not affected by HPRs nearly to the degree that live-hog and pork-belly futures prices are affected. This seems plausible because supplies of hogs are directly related to supply numbers in the HPR. However, cattle prices are

only related in that changes in hog inventories will change the demand for beef, because beef and pork are substitute products.

For feeder-cattle, all time-horizons are immediately responsive to unanticipated breeding hog inventories (Figure 4). In addition, the time-horizon 4-5 months contracts respond to unanticipated market hog information. However, market hog information is generally not a factor. For breeding hogs, all of the initial parameters are significant and around -0.3. However, they tend to become statistically insignificant and move towards zero.

SUMMARY

If markets are efficient, then known or expected information should be reflected in prices. Therefore, prices should not react to expected information after actual values of the variables in question are realized. Once the new information is known, prices should respond to that information to the extent to which it was unanticipated. This research has examined the efficiency of livestock futures contract price reactions to USDA Hogs and Pigs reports. This was accomplished through the use of the survey data to distinguish between expected and unexpected information.

None of the livestock futures contracts react to anticipated information. This is true for all commodities, suggesting that the anticipated information is incorporated into futures prices.

All of the commodity contracts for all time-horizons react immediately to unanticipated HPR information. However, there is evidence to suggest that many of the prices overreact to the information. This is seen through the graphs of the parameter estimates for the cumulative price change models. The general trend is for prices to respond immediately to the HPR and then trend back toward zero. The exception is with pork bellies, in which prices tend to react, then overreact, and then return to their original levels. These results tends to reject the notion of efficiency of prices for those contracts. However, price limits and high execution costs may preclude the existence of profitable trading strategies, especially for deferred contracts.

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Table 1. Response of Livestock Futures Contract Prices to Unanticipated Information in the Hogs and Pigs Report from the Close of Trade on the Day of the Hogs and Pigs Report to the Open of Trade One Day Following the Hogs and Pigs Report

Time-Horizon (Months)	Coefficient Estimates[a]			H_0: β_1, β_2 = 0
	Intercept	Breeding Hogs	Market	Chi-Square(2)[b]
--Live Hogs--				
1-2	0.765	-0.457*	-0.901**	25.66**
	(0.459)	(0.201)	(0.297)	
2-3	0.787	-0.649**	-0.985**	26.37**
	(0.515)	(0.232)	(0.335)	
4-5	0.686	-1.401**	-1.531*	14.03**
	(0.902)	(0.519)	(0.620)	
7-8	0.630	-1.368**	-1.114**	22.21**
	(0.630)	(0.362)	(0.430)	
10-11	0.544	-1.121**	-0.835*	26.11**
	(0.532)	(0.298)	(0.344)	
--Pork Bellies--				
2-5	-0.147	-1.223**	-1.653**	17.12**
	(0.830)	(0.461)	(0.606)	
5-8	0.109	-1.369**	-1.350**	18.52**
	(0.735)	(0.431)	(0.522)	
8-11	0.097	-1.268**	-1.124**	21.92**
	(0.638)	(0.371)	(0.426)	
--Live Cattle--				
1-2	0.255	-0.199*	-0.256**	44.13**
	(0.158)	(0.068)	(0.099)	
2-3	0.263	-0.246**	-0.261*	33.21**
	(0.201)	(0.088)	(0.126)	
4-5	0.187	-0.276**	-0.183	41.52**
	(0.179)	(0.080)	(0.111)	
6-7	0.215	-0.272**	-0.179*	43.70**
	(0.171)	(0.076)	(0.107)	
8-9	0.317	-0.254**	-0.234*	42.30**
	(0.174)	(0.076)	(0.109)	
10-11	0.241	-0.246**	-0.177	38.69**
	(0.166)	(0.072)	(0.104)	
--Feeder Cattle--				
1-2	-0.028	-0.326**	-0.167	51.08**
	(0.172)	(0.078)	(0.171)	
2-3	0.092	-0.304**	-0.277	49.38**
	(0.182)	(0.081)	(0.113)	
4-5	0.130	-0.291**	-0.194*	59.06**
	(0.148)	(0.065)	(0.094)	
7-8	-0.025	-0.262**	-0.035	46.49**
	(0.139)	(0.060)	(0.086)	

Note: Standard errors of the estimated coefficients appear in parentheses. One and two asterisks represent significance at the 5% and 1% levels, respectively. One sided t-tests are performed for coefficient estimates β_1 and β_2.

[a]The coefficient estimates are interpreted as the percent change in price (dependent variable) for each percent of a bearish forecast error.

[b]Chi-Square(2) = Chi-Square test with two degrees of freedom.

Table 2. Likelihood-Ratio Statistics of the Joint Tests of Changes in Coefficient Estimates in the Livestock Futures Prices Change Models Given Unanticipated Information in the Hogs and Pigs Report[a]

Time-Horizon (Months)	Price Change Model[b]								
	C1	O2	C2	O3	C3	O4	C4	O5	C5
--Live Hogs--									
1-2	7.44*	5.73	1.10	0.67	0.40	5.48	2.32	2.73	0.24
2-3	4.52	1.38	1.18	0.20	1.07	0.60	0.03	0.49	1.82
4-5	7.27*	0.57	0.06	2.26	1.59	2.58	0.46	2.24	0.19
7-8	3.60	10.75**	17.15**	15.04**	29.67**	15.60**	25.92**	14.42*	14.77**
10-11	3.60	19.44**	19.46**	19.84**	20.89**	4.58	8.20*	5.95	10.92**
--Pork Bellies--									
2-5	0.17	0.43	0.80	10.80*	0.23	3.58	0.06	0.13	0.21
5-8	1.65	38.76**	4.39	1.83	0.86	8.20*	0.30	2.35	0.40
8-11	2.19	0.16	0.09	0.69	0.86	1.13	0.96	1.17	0.09
--Live Cattle--									
1-2	6.81*	3.71	1.82	7.52*	0.85	7.27*	7.58*	8.00*	3.77
2-3	4.78	0.38	1.61	7.13**	0.81	5.25	5.99*	10.87**	8.36*
4-5	0.50	7.37*	1.83	0.77	6.06*	0.48	0.07	1.11	2.10
6-7	1.25	17.82**	9.30**	16.55**	4.17	7.79*	9.85**	0.24	1.40
8-9	2.64	6.82*	11.01**	21.24**	22.53**	10.11**	6.58*	1.64	1.45
10-11	3.07	11.76**	6.93*	40.69**	25.27**	19.73**	18.68**	1.96	18.67**
--Feeder Cattle--									
1-2	1.62	23.42**	5.74	9.45**	11.77**	1.78	0.24	8.01*	0.81
2-3	3.33	26.98**	7.85*	16.12**	15.88**	0.93	0.42	1.56	2.48
4-5	3.99	72.53**	10.63**	20.53**	46.03**	7.12*	3.43	1.48	4.57
7-8	12.58**	18.46**	9.64*	26.54**	47.03**	13.72**	5.00	0.99	2.09

Note: One and two asterisks represent significance at the five and one percent levels, respectively.

[a]These are chi-square statistics of the joint hypotheses that the slope parameter estimates are equal to those of the previous model's parameter estimates.

[b]The first character, or letter (O or C), refers to the open (O) or close (C) of trade. The second character, or number (1,...,5), refers to the number of days following the Hogs and Pigs report.

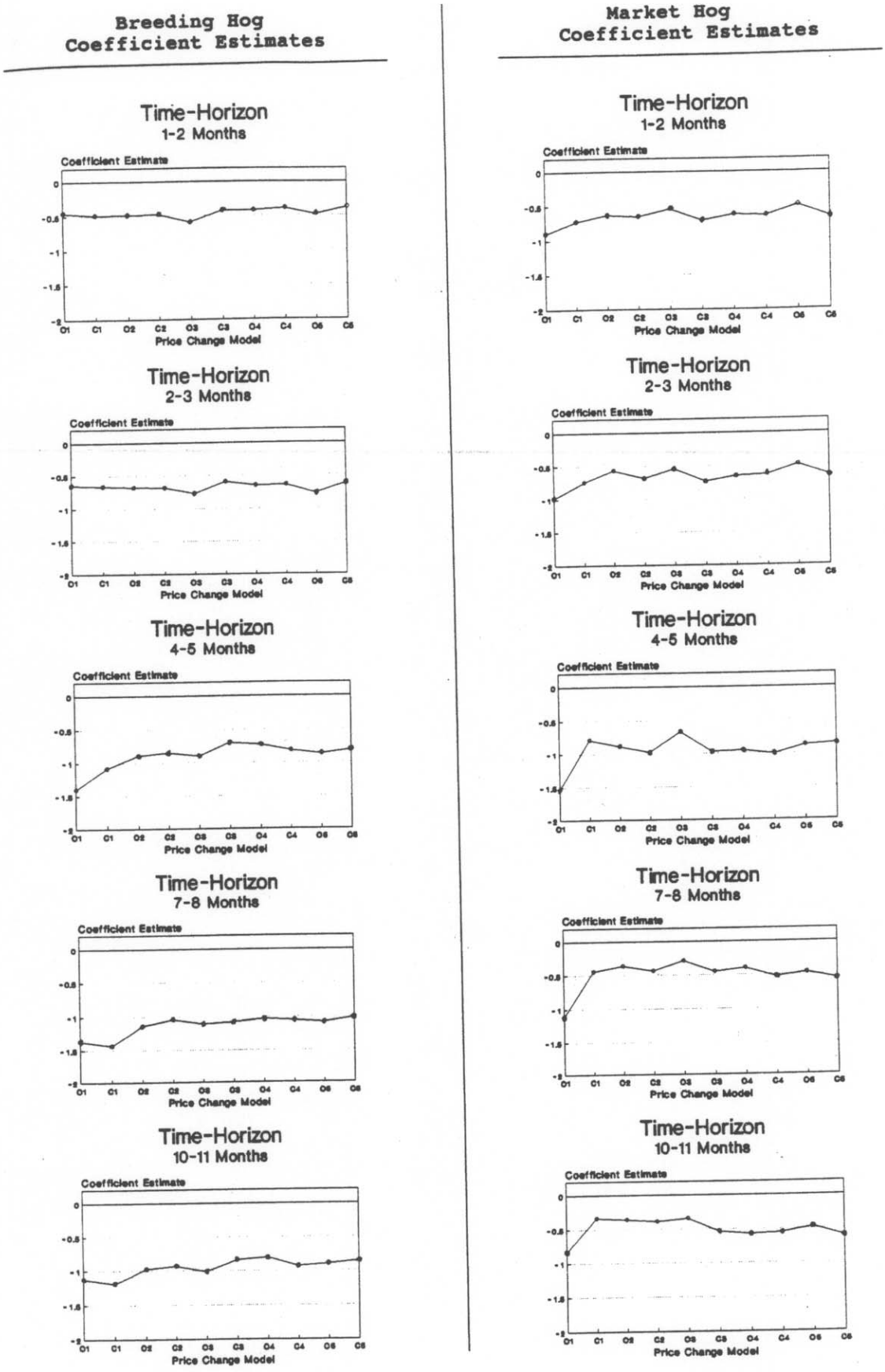
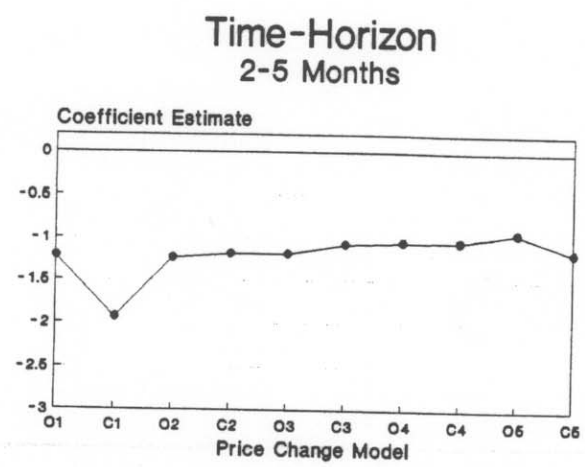
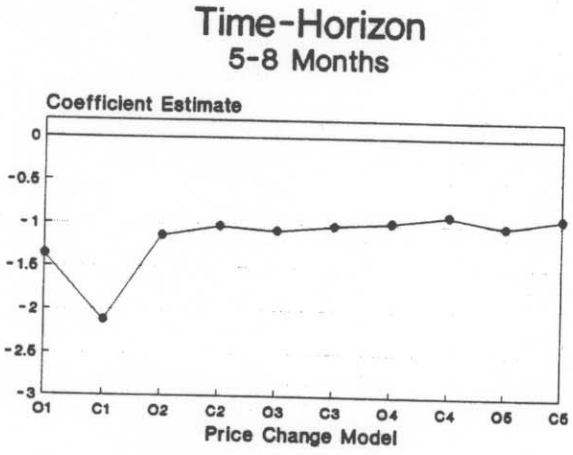
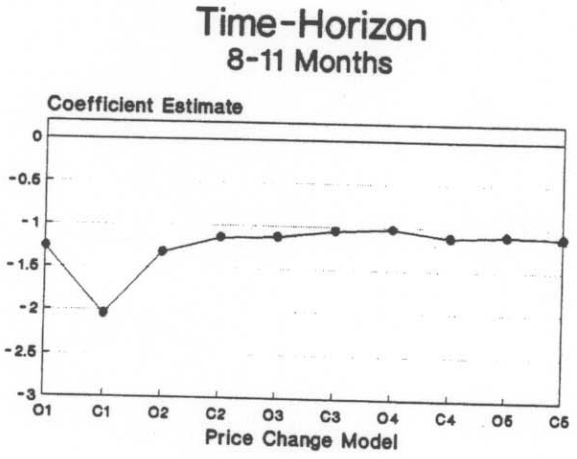


Figure 1. Cumulative Response of Live-Hog Futures Prices to Unanticipated Changes in Breeding and Market Hog Information as Time from the Hogs and Pigs Report Release Date Passes

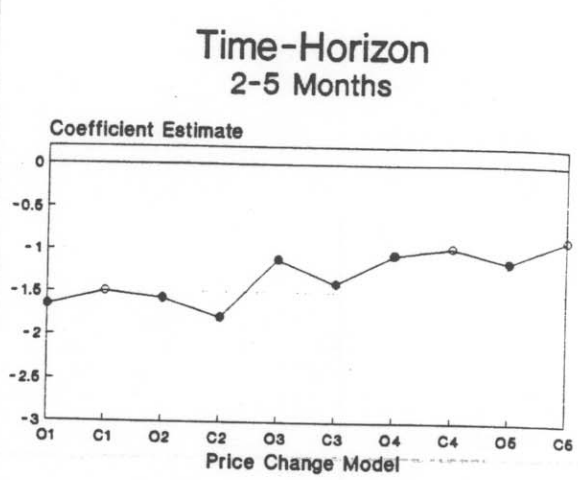
Breeding Hog Coefficient Estimates

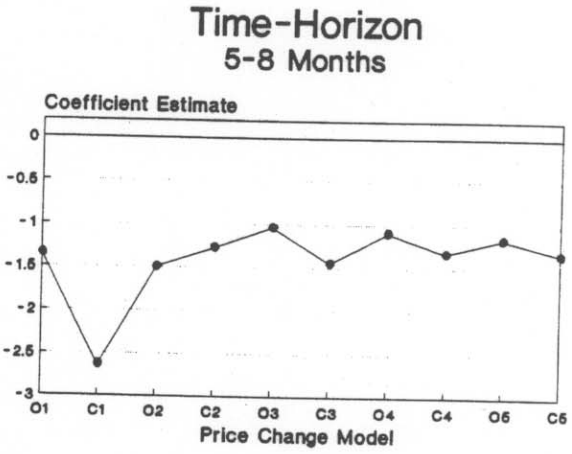






Market Hog Coefficient Estimates





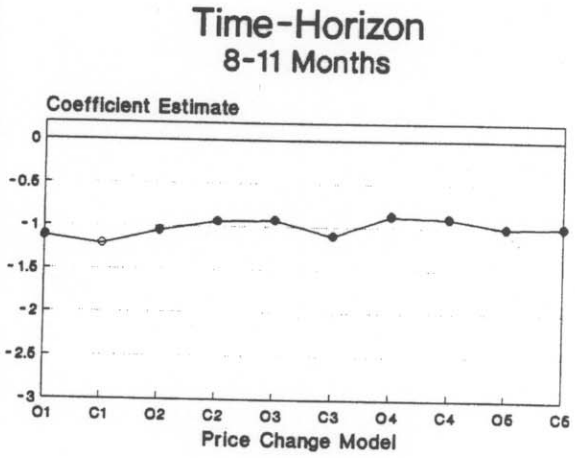


Figure 2. **Cumulative Response of Pork-Belly Futures Prices to Unanticipated Changes in Breeding and Market Hog Information as Time from the Hogs and Pigs Report Release Date Passes**

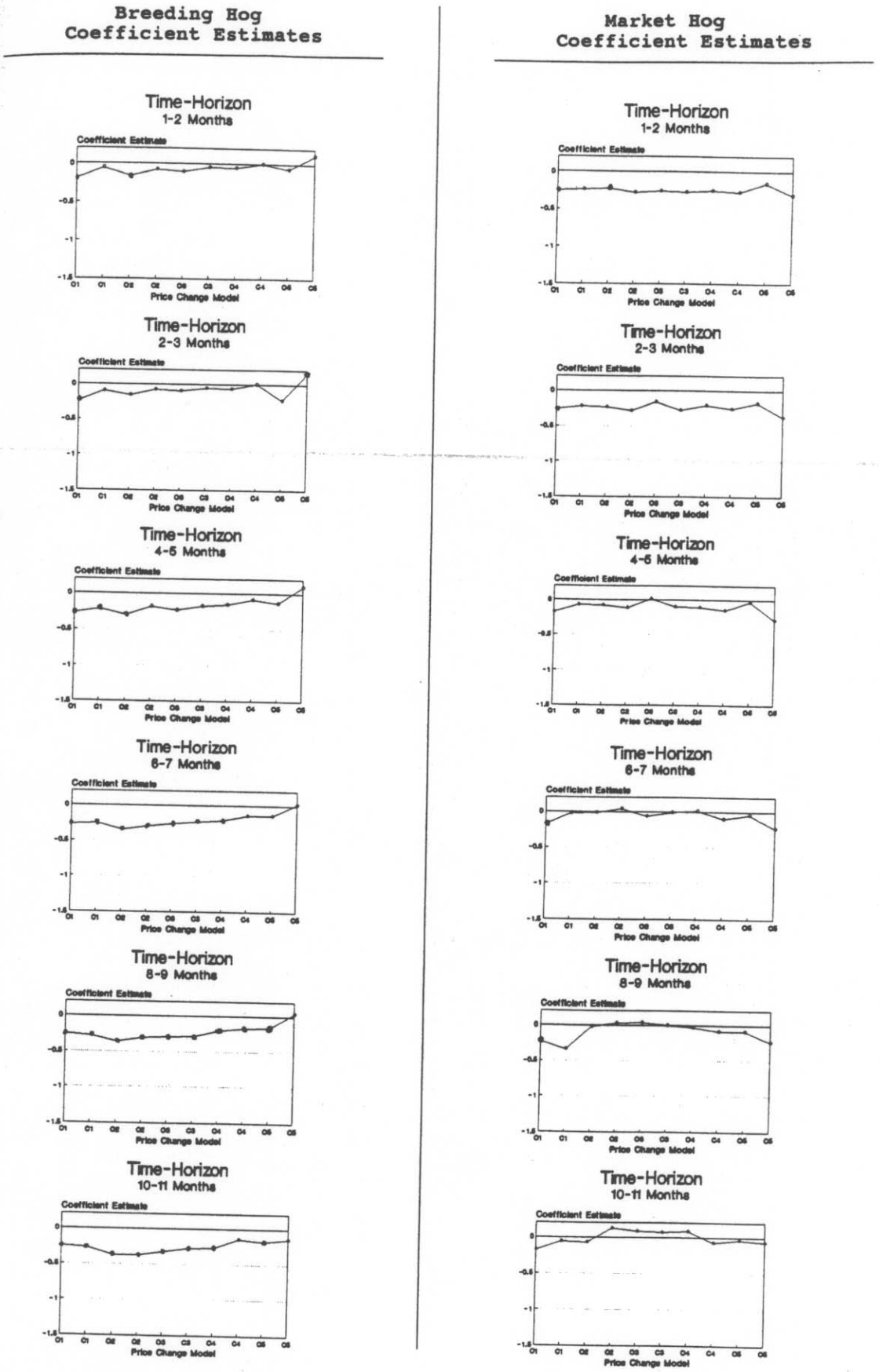


Figure 3. Cumulative Response of Live-Cattle Futures Prices to Unanticipated Changes in Breeding and Market Hog Information as Time from the Hogs and Pigs Report Release Date Passes

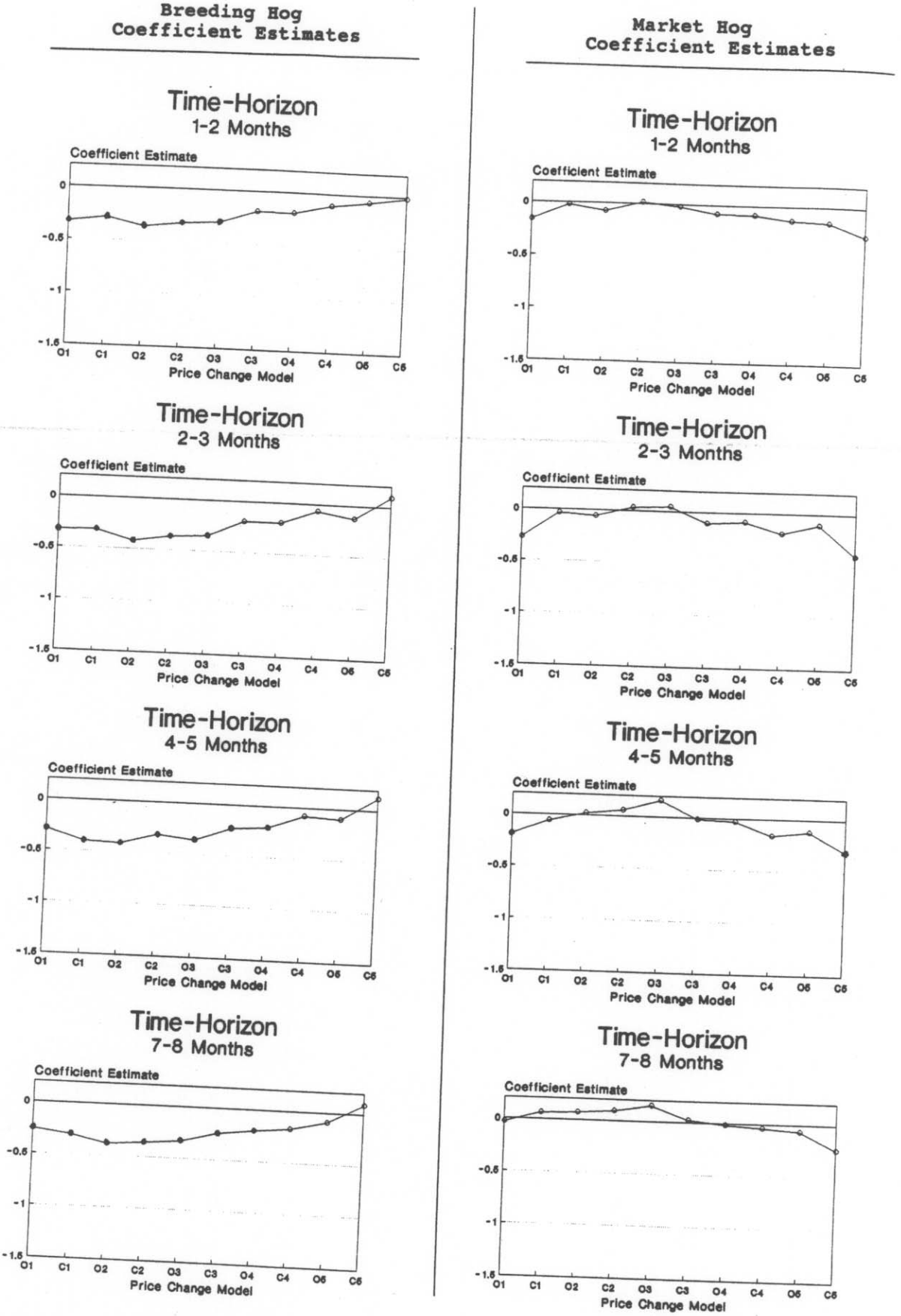


Figure 4. Cumulative Response of Feeder-Cattle Futures Prices to Unanticipated Changes in Breeding and Market Hog Information as Time from the Hogs and Pigs Report Release Date Passes