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**AJAE Appendix for “Rights-based Management and Alaska Pollock Processors'  
Supply”**

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Note: The material contained herein is supplementary to the article named in the title and published in the American Journal of Agricultural Economics (AJAE).

## Appendix A – Unit Root Tests

Below are the results of the unit root tests referenced in the paper named above.

**Table 1 ADF-GLS Unit Root Tests**

Series	Intercept Only	Intercept and Trend
Surimi Price ( $P_{sur}$ )	-0.82	-2.64
Fillet Price ( $P_{fill}$ )	-2.09**	-2.18
Total Harvest ( $H_{total}$ )	-0.84	-0.06
Total Fillet Production ( $Fillet_{total}$ )	0.82	-0.14
Total Surimi Production ( $Surimi_{total}$ )	-8.63**	-0.80
Inshore Harvest ( $H_{inshore}$ )	0.09	-0.47
Inshore Fillet Production ( $Fillet_{inshore}$ )	0.49	-0.09
Inshore Surimi Production ( $Surimi_{inshore}$ )	-0.75	-0.99
Offshore Harvest ( $H_{offshore}$ )	-0.31	-0.49
Offshore Fillet Production ( $Fillet_{offshore}$ )	0.15	-0.08
Offshore Surimi Production ( $Surimi_{offshore}$ )	-0.84	-0.98
NJ Inshore Harvest ( $H_{NJ inshore}$ )	-0.02	-1.02
NJ Inshore Fillet Production ( $Fillet_{NJ inshore}$ )	0.03	-0.16
NJ Inshore Surimi Production ( $Surimi_{NJ inshore}$ )	-0.90	-1.26
CP Harvest ( $H_{CP}$ )	-0.25	0.26
CP Fillet Production ( $Fillet_{CP}$ )	0.00	-0.11
CP Surimi Production ( $Surimi_{CP}$ )	-0.52	-1.11

Notes: The null of the test is that the series has a unit root. The modified BIC was used to determine first differenced dependent variable lag length in the auxiliary regression. (\*\*) denotes significance at the 5 percent level. (\*) denotes significance at the 10 percent level.

**Table 2 Zivot-Andrews Tests**

Series	Model A		Model C	
	min <i>t</i> -stat	break	min <i>t</i> -stat	break
$P_{sur}$	-4.38	Aug-94	-4.27	Dec-99
$P_{fill}$	-5.67**	Feb-96	-5.64**	Feb-96
$H_{total}$	-4.15	Jun-01	-4.84	Feb-01
$Fillet_{total}$	-4.27	Jun-01	-4.18	Jun-01
$Surimi_{total}$	-4.15	Jul-00	-4.02	Jul-00
$H_{inshore}$	-4.58	Sep-95	-4.58	Sep-95
$Fillet_{inshore}$	-5.55**	Jun-01	-6.40**	Jun-01
$Surimi_{inshore}$	-4.16	Jul-99	-3.92	Jul-99
$H_{offshore}$	-4.47	Jun-01	-5.27*	Dec-98
$Fillet_{offshore}$	-3.60	May-01	-3.58	Jun-97
$Surimi_{offshore}$	-4.08	Jul-00	-3.96	Feb-98
$H_{NJ\ inshore}$	-4.27	May-95	-4.37	Jan-95
$Fillet_{NJ\ inshore}$	3.49	Jun-01	-3.43	Jun-01
$Surimi_{NJ\ inshore}$	-2.98	Jun-01	-4.59	Jul-99
$H_{CP}$	-3.66	May-01	-4.29	Aug-00
$Fillet_{CP}$	-3.59	May-01	-3.38	Feb-91
$Surimi_{CP}$	-3.94	Jul-00	-3.80	Jul-00

Notes: The null of the test is that the series has a unit root. Model A allows for an endogenous level shift in the test regression and Model C allows for both an endogenous level shift and deterministic trend break. The date associated with the minimum *t*-stat is given in the “break” columns. (\*\*) denotes significance at the 5 percent level. (\*) denotes significance at the 10 percent level.

## Appendix B – Monte Carlo Experiments on DOLS Estimates with Erroneous Structural Breaks

Efficient cointegration estimation procedures, such as dynamic ordinary least squares (DOLS) can be modified to include a structural break in the cointegrating relationship (see Hayashi 2000). A logical question that arises from this alteration is what happens if the structural break is erroneously imposed or the exact date of the break is not

known? A Monte Carlo (MC) experiment is presented in this appendix to address these questions. The experiment is conducted as follows. First, three series are generated under a unit root data generating process (DGP) such that:

$$\begin{aligned} x_i(t) &= x_i(t-1) + \varepsilon_i(t), i = 1, 2, 3 \\ \text{with } \varepsilon_i(t) &\sim iid N(0, \sigma_i^2) \end{aligned} \quad (1.1).$$

A fourth variable is then generated under the cointegrating relationship specified as:

$$\begin{aligned} y(t) &= c + \beta_1 x_1(t) + \beta_2 x_2(t) + \beta_3 x_3(t) + (\beta_1 + \delta_1) x_1(t) D_\tau + (\beta_2 + \delta_2) x_2(t) D_\tau + \mu(t) \\ \text{with } D_\tau &= 1 \text{ if } \tau > t, 0 \text{ otherwise and } \mu(t) \sim iid N(0, \sigma_\mu^2) \end{aligned} \quad (1.2).$$

This specification is thus one of a partial structural break in the cointegrating relationship between  $y$ ,  $x_1$ ,  $x_2$ , and  $x_3$ . However, to test the ability of the DOLS estimation technique at estimating the cointegrating relationship when a break is erroneously imposed a full structural break model is estimated. That is, the estimated equation is of the form:

$$\begin{aligned} y(t) &= c + B\mathbf{X}(t) + (B + \Delta)\mathbf{X}(t)D_\tau(t) + \mu(t) \\ \text{with } B &= [\beta_1 \ \beta_2 \ \beta_3], B + \Delta = [(\beta_1 + \delta_1) \ (\beta_2 + \delta_2) \ (\beta_3 + \delta_3)], \text{ and } \mathbf{X}(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} \end{aligned} \quad (1.3)$$

If the true DGP of (1.2) is estimated under the assumed form (1.3) by DOLS and the DOLS technique is able to handle this erroneous inclusion of a break then the estimate for the parameter  $\delta_3$  should be equal to zero. Likewise, the  $t$ -statistic associated with this parameter should fail to reject the null that the parameter is equal to zero. This is thus the basis for testing the effectiveness of the DOLS estimation technique at handling erroneously imposed structural breaks in the cointegrating relationship.

Below, table 3 provides the results of the MC experiment using 5,000 iterations where the data was generated under (1.1) and (1.2) and the estimated cointegrating relationship was of the form given in (1.3). The sample size for each experiment was  $T = 132$ , where  $t = T$  is the final date of the sample. The variance for each *iid* error was set to one (i.e.  $\sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma_\mu^2 = 1$ ). All cointegrating parameters in the DGP (1.2) are set to one. MC experiments were conducted under three different break date locations to see if the location of the break influenced the parameter estimates. The true break dates are given at the top of table 3. The break dates used in the DOLS estimation were however not treated as given, but rather estimated. The estimated break date came from the location of the minimum  $t$ -statistic from the Gregory and Hansen (1996) test for cointegration with a break in the cointegrating relationship at an unknown time. The “Mean” column gives the mean parameter estimate from the 5,000 iterations with the standard deviation of the 5,000 estimates given in parentheses. The “Power” column gives the power of the  $t$ -statistic under a null of zero using a five percent level of significance, where the population of the  $t$ -statistic are those statistics generated from each individual run of the MC experiment. The standard error of the parameter estimates used in the calculation the  $t$ -statistic are corrected for serial correlation using the VARHAC type correction described in Hayashi (2000).

The mean values of the parameter estimates are near the true values for those parameters and the standard deviations are relatively low, suggesting that the DOLS technique is accurately estimating the parameters even with the endogenously determined break date and erroneously imposed break on the variable  $x_3$ . Furthermore, the power of the  $t$ -statistics on parameters for which the null is false is near one, regardless of the

break location. This means that in almost all instances the null is being correctly rejected. For the parameter in which the null is correct,  $\delta_3$ , the power should be equal to the level of significance (i.e. 0.05). However, for all break locations, the power was considerably higher than the five percent level, suggesting an over rejection of the null for the erroneously included parameter. This suggests a  $t$ -statistic distribution for this parameter that has more weight in the tales of the distribution than it should.

In summary, the DOLS technique appears to accurately estimate all the parameters when the break date is endogenously determined and an erroneous break is included for one of the parameters. However,  $t$ -statistic for the post-break parameter on the relationship that did not undergo a structural break does appear to, on average, reject the null of a zero parameter value too frequently.

**Table 3: Monte Carlo Experiment Results**

Parameter	$\tau = T/4$		$\tau = T/2$		$\tau = 3T/4$	
	Mean	Power	Mean	Power	Mean	Power
$\beta_1$	1.08 (0.29)	0.99	1.04 (0.21)	0.99	1.03 (0.17)	1.00
$\beta_2$	1.08 (0.29)	0.98	1.05 (0.21)	0.99	1.03 (0.17)	0.99
$\beta_3$	1.00 (0.30)	0.98	0.99 (0.22)	0.98	1.00 (0.18)	0.99
$\delta_1$	0.93 (0.28)	0.97	0.96 (0.20)	0.98	0.96 (0.22)	0.95
$\delta_2$	0.93 (0.29)	0.97	0.96 (0.20)	0.98	0.97 (0.23)	0.95
$\delta_3$	0.00 (0.29)	0.33	0.00 (0.22)	0.26	0.00 (0.24)	0.17

Notes: For all DOLS estimations, the Lead/lag selection was determined by BIC Minimization with the maximum lags set at 6.

## References

Gregory, A.W., and B. Hansen. 1996. "Residual-based Tests for Cointegration in Models with Regime and Trend Shifts." *Oxford Bulletin of Economics and Statistics* 58:555-60.

Hayashi, F. 2000. *Econometrics*. Princeton, N.J.: Princeton University Press.